"Survey our empire and behold our home!"
—Byron.

LIPPINCOTT'S
HOME MANUALS

EDITED BY
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HOME AND COMMUNITY HYGIENE

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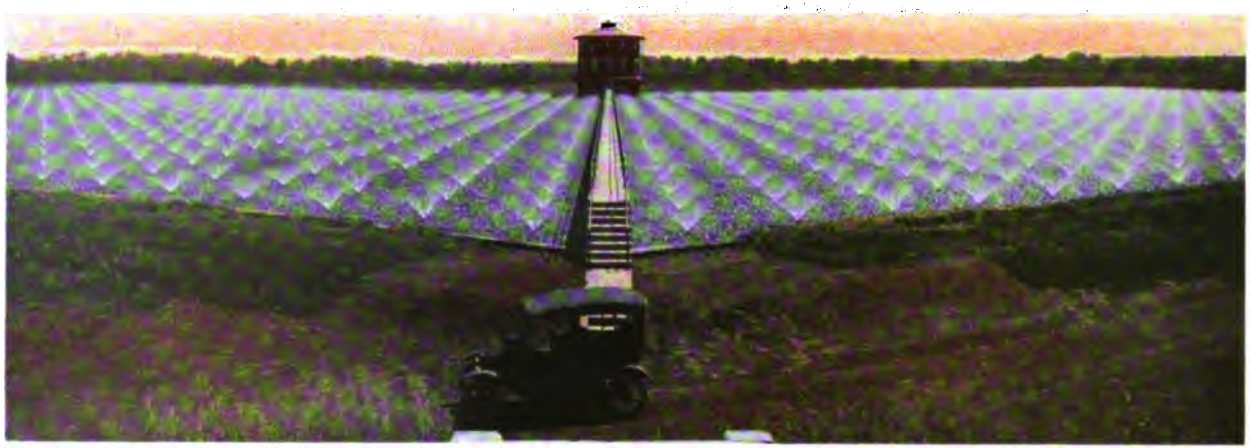

SPRINKLING FILTER AT COLUMBUS, OHIO, SEWAGE TREATMENT WORKS

Total area 10 acres. It is filled 5½ feet deep with pieces of broken limestone, 1 to 3 inches in size. There are 210 sprinkling nozzles per acre

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HOME AND COMMUNITY HYGIENE

A TEXT-BOOK OF PERSONAL AND PUBLIC HEALTH

BY

JEAN BROADHURST, PH.D.
ASSISTANT PROFESSOR OF BIOLOGY, TEACHERS COLLEGE
COLUMBIA UNIVERSITY

118 ILLUSTRATIONS

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TO THE NURSES, TEACHERS
AND MOTHERS OF AMERICA

PREFACE

THIS book is so planned that any one reading first the two introductory chapters (I and II) may read the remaining chapters in any preferred sequence. Household Economics students as well as housekeepers may prefer to begin with Chapter XIII, The Home, passing at any desired point to related chapters. For example, interest in food may suggest next the chapter on food, or on milk; household pets may lead to the chapter on transfer of disease or cleaning methods to the chapter on disinfection.

Nurses will find many possible starting points, though school nurses as well as teachers may choose Chapter XV, on the school, from which point drinking fountains may lead to the chapter on water, school epidemics to the chapter on prevention of disease, or the ventilation problem to the chapter on air and ventilation, etc.

This flexible plan is further made possible by the addition of a glossary containing simple definitions to which the reader is referred by a (G) placed after any technical term the first time it occurs in each chapter. This glossary and the introductory character of the first two chapters insures its readability to any really interested student in normal schools and colleges. This book has been made as brief as the varied chapter content would allow, much of the material ordinarily included being condensed into tables. Advanced students should continue to use the more advanced texts, some of which are most valuable and comprehensive. (See reference list in Appendix.)

The problems are meant as suggestions only. They are not meant as recitation or review questions, but to indicate possible lines of departure for individual work, or to lead to the immediate or practical application of the contained subject-matter. An effort has been made to secure variety in these problems; very often, however, a problem in one chapter can, with the modification of a word or two, be applied to another.

This book will fail in its purpose if it does not lead to increased practical application of the hygienic measures implied and recommended—both in the home and in the community.

J. B.

July, 1918.

ACKNOWLEDGMENTS

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Recognition is also due to Dr. Chapin and the John Wiley Publishing Company for permission to reprint the long extract credited to Dr. Chapin in Chapter IX, and to Dr. Lusk and the Saunders Publishing Company to reprint the rules of Saving and Safety in Chapter III.

For illustrative material acknowledgment of original photographs is rendered to Dr. C. B. Hoover for the sprinkling filter (Frontispiece), to Dr. F. L. Rector for Fig. 32, to the Spencer Lens Co. for Fig. 1, and to Dr. Carroll G. Bull for Figs. 50, 51, and 102. Two plates from Moore's Bovine Tuberculosis were loaned by the Macmillan Company, Figs. 93, 95 and 96; one from Ritchie's Primer of Sanitation by the World Publishing Company, Fig. 35; and one from Giltner's Microbiology by John Wiley Co., Fig. 13.

The Northwestern Steel and Iron Works, Eau Claire, Wisconsin, allowed the use of Fig. 18, and the Heinz Company of Fig. 19. Permission from the authors concerned was given for Fig. 2, from Powell's Successful Canning and Preserving; Figs. 4, 46, 57, 58, 60, and 61 from Emerson's Chemical Diagnosis; Figs. 56 and 59 from Steele, International Clinics; Fig. 42, from Ross's The Reduction of Domestic Flies; Figs. 55a and 101 from Thomas and Ivy's Applied Immunology; and Fig. 94 from Wilson's Medical Diagnosis.

Permission to reprint the chart used in Fig. 14 was granted by the Society for Improving the Condition of the Poor. Pro-

fessor Thomas D. Wood gave permission to reprint the charts of the American Medical Association, Figs. 49, 78, 81, 82, 83, 84, 86, 97, 103, 105, 106, 111, and 112.

The Public Health Service provided the original for Figs. 108, 109, and 114. The Children's Bureau gave permission to reprint Figs. 91 and 92; the New Jersey State Health Department for Fig. 98; the New York State Health Department for the chart opposite p. 186, and Figs. 39, 48, 54, 77, 104. The Horace Mann School, New York City, gave the two blanks used as Fig. 85 and reprinted on p. 269. To the Bureau of Animal Industry is due credit for Figs. 20, 26, 27, and 45; to the Department of Agriculture for Figs. 22 and 24; and to Russell and Hastings as well as Moore and Ward of the Department of Agriculture for Fig. 20; to the Virginia State Health Department for Fig. 37; to the Chicago Department of Health for Fig. 90; to Hampton Institute for Fig. 44; to Geneva Experiment Station for Fig. 23; and to the Department of Agriculture, Cornell University, for Fig. 25.

Illustrations have been redrawn as follows: Fig. 3, after Nocht and Mayer; from Winslow's Healthy Living, Figs. 6 and 115; from Mansfield's Histology of Medicinal Plants, Fig. 16; after Whitaker, Bureau of Animal Industry, Fig. 21; from Ritchie's Primer of Sanitation, Fig. 29; from the Health News of New York State for Fig. 41; from Ogden's Rural Hygiene, Figs. 62 to 65 inclusive; Talbot's House Sanitation, Fig. 70; Raynes's Domestic Sanitary Engineering and Plumbing, Figs. 71, 72, 73; Journal of Bacteriology, Fig. 79; Wilson's Field Sanitation, Figs. 99 and 100; and the United Kingdom Temperance and General Provident Institution, Fig. 110.

Figures 75 and 76 were provided by Miss Tovey; Fig. 40 by Mr. G. W. Prall; Figs. 53 and 89 by Miss O. Pye; Fig. 113 by Miss E. P. Sheppard. The illustrations which were redrawn, and all drawings not otherwise credited, were made by Miss Margery Stewart.

INTRODUCTION

THE cloak of mystery which was once wrapped about the art of medicine has to a considerable extent been discarded. The physician of to-day takes both patient and public into his confidence and so far as possible secures their intelligent aid and co-operation in the difficult task of repairing the ravages of disease.

If this is desirable in the domain of curative medicine, it is even more important in the prevention of disease. The principles of personal hygiene and public sanitation must be made familiar to the individual citizen if they are to be effectively applied; for only by hearty and informed co-operation can the possible fruits of public health be garnered.

The science which teaches us how to preserve health lends itself with unusual facility to popular exposition. Its main principles are simple and few in number. They involve on the one hand broad biologic principles which appeal strongly to all who are open to the absorbing interest of fundamental scientific laws; and on the other hand in their practical applications they reveal points of contact with the most searching problems of social and economic organization, problems of housing, of industrial hygiene, of incomes and hours of labor.

It is no wonder, then, that courses in "Hygiene," "Sanitary Science," "Preventive Medicine," and "Public Health" are being given with increasing frequency, not only in schools of medicine and nursing but in departments of home economics, in engineering schools and academic colleges. Some course of this kind, adapted to the special needs of the class of students in question, should indeed form an essential and required part of every system of education, from the elementary school to the university. Yet strangely enough there has been so far no satisfactory text available for courses of this kind to be given to mature but non-technical students. Rosenau's "Preventive Medicine and Hygiene" is admirable for the medical school. Sedgwick's "Principles of Sanitary Science," Chapin's "Sources and Modes of Infection," Fisher and Fish's "How to Live" are invaluable sources of collateral reading on special phases of the subject. A text-book

which covered the whole field of disease prevention and health conservation in an elementary but authoritative way has, however, been much needed. This need Professor Broadhurst has met in the present volume.

The subject has been approached throughout from the practical standpoint of the home-maker. Problems of sanitary engineering and health administration are touched upon lightly, but sufficiently for the uses of the average citizen; while those applications which are of immediate moment in the household are dwelt upon in helpful detail. The book will, therefore, be of special value to the student of household administration and to the student of nursing, who must be expert in this art. In addition to filling the need of a text-book in schools of home economics and nursing, it should have a wide appeal to the general reader who desires familiarity with the principles which govern the management of the living machine and its protection against harmful environmental conditions.

The Great War has emphasized, as never before, the importance of national strength and national efficiency; but national efficiency rests upon personal health. There could therefore be no more timely occasion for the appearance of a work of this character; and Professor Broadhurst has performed an act of patriotic service in preparing a brief and popular but comprehensive and accurate statement of the things which we all ought to know in order to keep fit for our individual and collective parts in the world conflict and in the reconstruction that is to come after.

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Professor of Public Health
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CONTENTS

HOME AND COMMUNITY HYGIENE

CHAPTER I

BACTERIA AND OTHER MICRO-ORGANISMS

So much is said and written nowadays about bacteria that practically all people have a general idea that they are very tiny organisms which are very destructive to foods and very injurious to human beings. While this is true, it is but part of the truth, as will be shown later.

We generally use the word, bacteria, in a very comprehensive sense, to include both microscopic plants and animals which have these destructive powers. Plants and animals, as we ordinarily think of them, differ from each other greatly in appearance and in structure. One of the mental tests applied in the grading of children, and for the isolation of the feeble minded, includes in the questions which are supposed to be answered by any normal eight-year-old child, "What is a plant?" Mature people cannot answer this question so glibly. They know so many plants that vary from the ordinary garden vegetable, or window plant, that they hesitate; they can't describe them as green, because they know that mushrooms are plants, but are not green; they cannot define them by saying they bear flowers or seeds, because they know that ferns are plants although they never produce flowers or seeds; they cannot define all plants by any ordinary character of color, shape, size, etc., because such plants as the bacteria are so tiny and so colorless that they cannot be seen without a microscope (Fig. 1), and then best if they are stained with a colored dye or special stain. The types of animals vary just as greatly; the smallest animals are just as unlike our general idea of animals as bacteria are unlike our general idea of plants. These small plants and animals are really very much alike, though the animals are usually much larger than bacteria. Some of these small plants resemble the animals in possessing free swimming movement or motility (see Fig. 2).

General Structure.—Because of their small size—demanding the aid of a microscope—we term all of these small plants and animals micro-organisms. Most of these small animals that come

FIG. 1.—Small objects such as bacteria are studied through a compound microscope. A drop of material containing the organisms is put on a piece of glass, and placed over the opening so that light can be reflected through it from the mirror below. This microscope shows two lenses of different magnifying power, any one of which can be turned into position directly in line with the eyepiece.

under this heading are called protozoa, the first or simplest forms of animals (protos, first; zoa, animal). Most of the small plants belong to the bacteria, a popular group name for several kinds of tiny organisms, in which are included bacilli (*singular* bacillus), bac-

teria (*singular* bacterium), cocci (*singular* coccus), and spirilla (*singular* spirillum). These terms are based mainly on shape, the first two being rod-shaped (see Figs. 60 and 102), cocci being globular (see Fig. 58), and spirilla, spiral, as the name indicates. At present many new terms are being discussed, but we will follow

FIG. 2.—Bacteria from tomatoes showing numerous little extensions called flagella; motility is due to a whip-lash movement of these flagella.

the popular custom of referring to these organisms in a general way as bacteria; in mentioning the exact name, *e.g.,* typhoid bacillus or *Bacillus typhosus,* these other terms may occasionally be used. Different kinds of organisms may have compounds of such names, *e.g.,* meningo-coccus causing meningitis, and strepto-coccus causing erysipelas, sore throat, ear abscesses, etc. The protozoa are also subdivided into many divisions or groups; as examples may be cited

the organisms causing Texas fever in cattle (Fig. 45), "tsetse fly" disease (Fig. 3), and tropical dysentery (Fig. 4) and malaria (Fig. 46) in man.

Some of the smaller mold plants, such as those making the blue spots on old bread or leather goods, and the yeasts of bread, are commonly classed as micro-organisms. But for most of these tiny

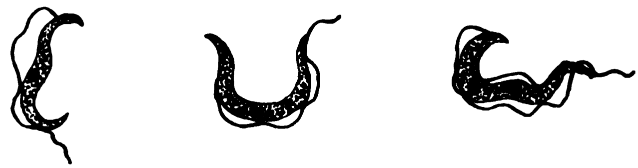

FIG. 3.—Trypanosomes transferred by the "tsetse" fly in an African disease affecting chiefly cattle and horses. Similar trypanosomes cause "sleeping sickness" in man.

animals, molds, and bacteria the layman often uses the word micro-organisms. Bacteria and micro-organisms are often loosely used quite interchangeably. Microbes and germs are also equivalent terms; and some, in a half joking way, speak of them as bugs.

What, then, are these micro-organisms? They are tiny plants

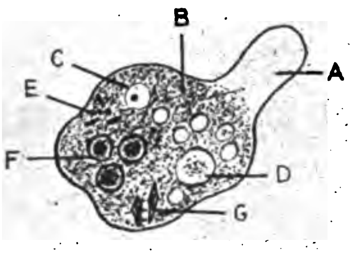

FIG. 4.—An intestinal amœba, *Entamœba histolytica*. Some idea of the relative size of such protozoa may be gained by noticing the bacteria (E) and the blood-corpuscles (F) inside this amœba. As these small animals move and engulf food material (such as bacteria) changes occur in their outlines and in the relative size of the clear areas shown in A.

or animals, so tiny that most of them consist of but a single cell or unit of structure.

Cellular Structure of Plants and Animals.—Large plants and animals consist of many cells or units of structure. A cut or section through the skin or through any other part of your body would show under the microscope dozens or hundreds of tiny cells.

The same is true of leaves, stems, or roots of plants. Below is a view made of a leaf cut across from top to bottom (Fig. 5). The cells thus revealed differ in size and shape, and also in color and contents. These differences are related to the work of the cell, *e.g.,* transparent cells, like *E,* transmit light to the inner part of the leaf; hollow tubes, like *V,* carry water through the stem to the leaf.

Size of Bacteria.—With a microscope it would be very easy to recognize the different parts of ordinary plants and animals by the

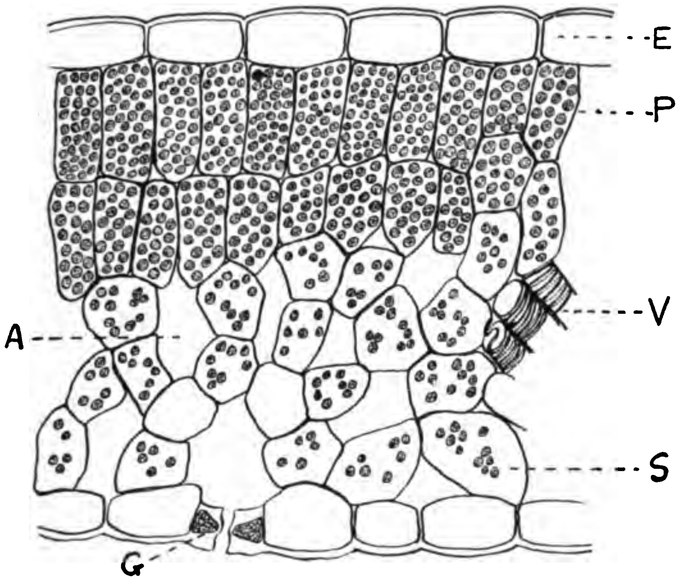

FIG. 5.—Cross-section of a leaf presented to show that several types of cells are present in many-celled plants and animals; E, covering layer or epidermis; P, cells manufacturing most of the sugar and starch; V, veins carrying water; S, protein-making cells; and G, pair of cells regulating the passage of gases and water. Figs. 3, 4, and 51 show whole animals or plants where each plant or animal consists of but a single cell.

kinds of cells that compose them. Adulteration of drugs is often proven in that way (Figs. 16 and 17). But the smallest plants and animals consist of but one cell each, and these single cells look very much alike—they are very tiny (3000 to 25,000 to an inch, often). When viewed under the microscope, which makes them look larger (1200 times as large in the microscope ordinarily used for bacteria), they even then seem but tiny dots or little rods about the

size of the period and the letters i and l used on this page. If you could divide the period or the letter i into 1200 little pieces, you would have the real size of some of the smaller bacteria.

Do you wonder, then, that until recently people never saw bacteria? That they thought the lightning soured the milk, that the witches killed the cows or that Providence caused the death of man?

Action of Bacteria.—Objects as tiny as these "look alike" to the ordinary observer. But even those which seem quite alike may behave very differently when placed in milk, broth, blood, or other food materials or "media." Some digest certain sugars very

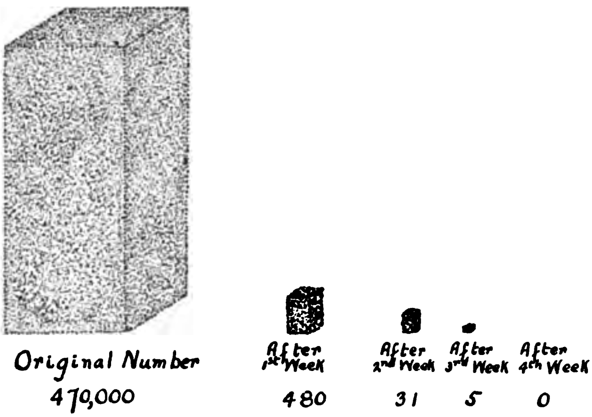

FIG. 6.—Typhoid bacteria in water die off at about the rate indicated by the above figures; this reduction is mainly due to such "natural agents" as sunlight and oxygen. On the other hand multiplication may be startlingly rapid when conditions for growth are favorable; the bulk indicated by the figure on the left may result from one bacterium in much less than four weeks.

rapidly; some "never touch them"; some, as they break up food materials, accumulate large amounts of acid or alkali; some attack proteins very readily, liquefying or dissolving them. The liquid condition of spoiled coffee jelly or gelatin, or the liquid interior of Camembert cheese is due to organisms having this liquefying power. These different powers enable them to grow luxuriantly in some of our food substances, and to attack even live plants and live animals.

An idea of the shapes of micro-organisms can be gained from the illustrations mentioned, but more important is their action on plant and animal substances. It is not what they look like, but

Fig. 7.—A very old growth of diphtheria on the slant surface of the agar in the bottom of the test-tube. (The cotton plug has been pushed down to the level of the top of the tube.)

FIG. 8.—Empty glass dish, Petri dish, used in cultivating bacteria. Figs. 43 and 67 show similar Petri dishes with bacteria growing on the agar in the lower half of the dish.

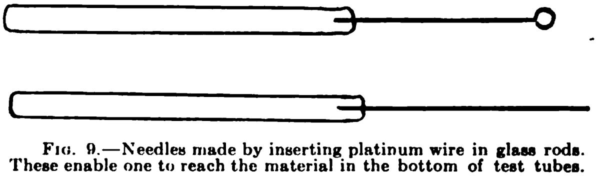

FIG. 9.—Needles made by inserting platinum wire in glass rods. These enable one to reach the material in the bottom of test tubes.

FIG. 10.—A pipette used in measuring or transferring large amounts of material. This holds one cubic centimetre (1 c.c.) (G).

what they do that interests us and makes us want to encourage or discourage their growth, or to get rid of them entirely.

Beneficial Micro-organisms.—Some of these tiny organisms are very useful to us. Yeasts and bacteria, which are really a great deal alike, themselves use up a little of the food substances in bread, in milk, and in soils; but nevertheless, we derive real benefit from their activities. The gas given out by the yeast scattered all through the bread makes the bread light; the acids formed by the milk bacteria cause it to sour, and coagulate, making a curd useful in cheese making; the soil organisms add large amounts of necessary minerals and nitrates to the soil.

Another important use of these organisms is that they bring about decay or decomposition. Manure and other excreted material are very quickly used as food by bacteria, and are finally changed to harmless inorganic substances. Our whole problem of sewage disposal would be very different if bacteria did not aid in that way. We do fully appreciate their aid in causing the decay of falling leaves, dead plants and dead animals. Without them, every dead tree and every dead animal would retain its original shape and bulk. Think what the earth would look like if none of the dead animals and plants ever decayed! Much of the material in plants and animals as it disintegrates goes back into the soil and forms food for other plants; many of these plants in turn furnish animals with food. How long would it take to use up all the available food materials, if dead plants and animals were not disintegrated by organisms and so used over again as food, thus helping keep up the cycle of food stuffs in nature?

Harmful Bacteria.—The benefits derived from bacteria are emphasized above to contradict the usual impression that bacteria are always harm-

ful. But the bacteria we shall discuss are mainly harmful ones, because they happen to destroy or injure food materials (*e.g.*, grains, potatoes, bread) we wish to conserve and use, or because they prefer to grow in our bodies, using up the food materials we need, forming poisonous wastes, or actually eating or disintegrating our body tissue. Examine the fester that forms around a splinter. Part of the white "matter" in the fester is made of white corpuscles from the blood that have migrated there to help

FIG. 11.—Colonies or masses of bacteria growing on agar or gelatin. This shows bacteria from the intestine, related to the *B. coli* organisms (Weigmann).

destroy the invading bacteria carried in with the splinter; part is composed of broken-down body cells and mucous excretions from them; and still another part is made up of the bacteria themselves. This gives a fairly good idea of the way bacteria grow in the body and injure it. Festers and sore throats are very localized infections; in tuberculosis (Fig. 94) many such local centres of growth may be distributed throughout the body, in the lymph-nodes (*G*), joints and lungs. Occasionally large areas are destroyed as the bacteria increase in number. Bacteria often multiply very rapidly (Fig. 6); a doubling of the number every twenty or thirty seconds has been observed, though it rarely progresses at that rate very long.

Spores.—When conditions become unfavorable. some bacteria have the power of going into a resting stage, in which their cell

substance is less sensitive to such unfavorable conditions. A difference in the amount of oxygen, the accumulation of their own injurious wastes, and a lack of food or water are some of the conditions that help produce this resting condition. Commonly the cell substance gathers in a concentrated mass called a spore (Fig. 102). These spores are very resistant to such conditions as heat; they are usually responsible for the spoilage of canned goods, because occasionally spores survive the canning process and later begin to grow inside the can.

FIG. 12.—A common organism (soil, water, etc.) showing very irregular branching colonies (Weigmann).

Similar adaptations are found in other plants as well as bacteria. Winter buds can stand intense cold, and seeds can usually stand extremes of both cold and heat—even boiling.

With favorable conditions each spore makes an organism like the original one. This multiplies, dividing into two, just as it did before spore formation occurred. This growing, multiplying stage is called the vegetative stage in contrast to the resting (or spore) stage.

Cultivation of Bacteria.—Bacteria are cultivated for study on solid substances like gelatin, and in such liquids as milk, and meat broth or bouillon. Agar, an extract of seaweed, is often used, as it makes a firmer substance than gelatin.

These substances may be worked with in test-tubes (Fig. 7); the solid substances are often used in covered glass dishes, called "plates" or Petri dishes (Fig. 8). The food used in these dishes

and tubes is heated to get rid of any other organisms, and then the desired organisms are transferred to the tubes or dishes by "needles" (Fig. 9), slender wires which are inserted in glass handles for ease in manipulation. When workers desire to take out or transfer a great deal of material, they use a pipette (Fig. 10). All tools are sterilized before use to keep them free from undesired organisms. Broth, gelatin, dishes, etc., may be heated in a steam boiler; needles are heated red-hot in a flame each time before using.

The tubes are usually plugged with a fairly tight roll of cotton. This filters any air passing into the tube and keeps out the bac-

FIG. 13.—Other colonies with irregular outlines. Colonies like those shown in Figs. 67, 75 and 76 are more common.

teria that might otherwise get in. Bacteria grown in the ways described above are commonly spoken of as cultures; if but one kind of organisms is present in a tube, we say the tube contains a pure culture. On solid substances or media the multiplication of these little organisms finally produces a mass that is visible to the naked eye (Fig. 11). These little masses are spoken of as colonies. Such colonies are often very irregular in outline (Figs. 12 and 13). Each colony presumably started from one single organism, and represents thousands of generations, and billions of individuals.

See Reference List at end of Appendix.

CHAPTER II

THE HUMAN MECHANISM IN RELATION TO HEALTH

For years the human body has been likened to an engine, a watch, or some similar mechanism. And old as the comparison is, it is difficult to find a better one. While this likeness fails if carried too far, there are many striking points of similarity, the most striking of which are listed below.

1. **Both Engine and Body are Complex Structures.**—Both the engine and the body are complicated structures composed of many different specialized parts—some of them highly specialized, such as the human eye and the carbureter in a motor car.

2. **Automatic Control.**—Some of the parts are so constructed as to make possible a remarkable degree of automatic control; this is well illustrated by the heat regulatory power of the skin and the thermostat device used in heating systems.

3. **Foundation Substances.**—There is a suggested similarity in the fact that in each there is a foundation substance modified to form various parts differing not only in use but in appearance, elasticity, hardness, etc. In the engine this foundation substance, iron, appears in such different forms as cast iron, wrought iron, and such an alloy as the carbonized iron called steel. In the body the foundation substance called protoplasm is modified into many different types of tissue; these are well illustrated by such familiar tissues as the skin, the muscle fibres composing lean meat, the glandular tissue making the bulk of liver and "sweetbreads," and bone, in which the lime deposits wholly change the appearance and elasticity of the protoplasmic foundation substance.

4. **Fuel Necessary.**—The likeness most often emphasized is with regard to fuel. Fuel is needed by the body and by the engine; and both must have suitable kinds of fuel and enough of it. This oldest and most familiar parallel is, strange to say, the one least often carried to its proper conclusion. No one would think of not choosing carefully the type of fuel to be supplied to an engine; this

engine needs coal, that one uses oil, and another must have natural gas, or perhaps, gasoline. But with our own bodies we carelessly assume that "all is grist that comes to our mill." If there is any selection, it is too often based on cost or taste rather than fuel value; "anything to fill them up" is a vulgar expression of this same attitude. An engineer selects his fuel with care, refusing to buy coal he has found to yield large amounts of such waste residue as "slag" or clinkers; but we calmly go on supplying our more sensitive human mechanisms with unsuitable materials, as if mere bulk were the chief or sole consideration.

In the body we often fail to relate properly the amount of fuel to the amount of work to be done. Those who care for furnaces or stoves constantly use such expressions as "need but a low fire," "keep piling on coal," and "running the furnace for all it is worth, if it takes a ton a day." But we are just beginning to consciously adapt the amount and kind of body fuel to the body needs. We may unconsciously eat less in warm weather, but it is quite unusual to find people reducing the amount on a day when the physical demands are going to be less—for example, on stay-at-home holidays and Sundays. The sense of over-fullness after the Sunday dinner is too common a sensation to make further illustration necessary. The impossibility of doing full work on half fuel is apparent to anyone. We never attempt it with engines, but human beings attempt it too often. A clearer recognition of the impossibility of continuing to yield any required output on insufficient food is necessary before we can get community support for satisfactory feeding of the submerged part of our population, where lack of fuel is evidenced by the large number of undersized, anemic or low-vitality individuals.

5. The Need of Oxygen.—The human body is like an engine in that plenty of oxygen must be provided to secure complete and economic utilization of the fuel. Motor car engines have a device for the proper admixture of air and fuel; in furnaces the air spaces between the coal are constantly filled with fresh air sucked in by the draft; or larger amounts of fresh air may be secured by forcing or pumping air with its necessary element, oxygen, through the burning bed of coal. In the human body this necessary oxygen is absorbed in the lungs and supplied to all parts of the body by the circulating blood. A lack in red corpuscles, the store houses of oxy-

gen, decreases the amount that can be absorbed and carried, and therefore the amount distributed to the cells. In disease (*e.g.*, pneumonia) the lung area available for absorption is decreased. Providing the proper amounts of oxygen may, therefore, be more of a problem than for engines.

6. Disposal of Wastes.—A sixth likeness is the necessity for prompt disposal of waste substances. The ashes must be removed, or they choke off the draft and clog the fire. In the human body it is just as essential that wastes must be eliminated (though the reasons are not exactly the same). Delayed intestinal elimination is harmful, because the blood in that region has increased opportunity to absorb certain poisonous wastes normally formed in the intestine; these poisons irritate and poison the cells to which they are carried, causing the headache, etc., characteristic of constipation. In constipation there is another danger that should be recognized. Bacteria in such held-back putrefying masses of food material may more easily invade the intestinal wall, causing serious diseases, *e.g.*, appendicitis.

7. Variations and Limits in Activity.—A seventh likeness lies in the fact that it is possible to speed up the activities of the body and the engine. As stated before, increased output demands increased fuel, increased oxygen, and increased elimination of waste. Too much may be demanded in both cases. In machines we have more definite indications when the limit is reached; there is a positive limit to the number of revolutions a wheel can make; the piston rod breaks, etc. In the body we don't have the same marked evidences as warnings: bones don't crack as piston rods do; nerve stimuli may carry one far past the danger line of physiological breakdown without sounding a warning; a lack in the food supply can be made up temporarily at the expense of body substance, etc. Though delayed in evidence in the body, the cumulative results are the same in both cases; physiological speed-limit regulations, too, should be observed strictly under penalty of the law.

8. Rest Necessary.—The need of rest furnishes an eighth parallel. There is an ingenious machine for testing the strength of metals. Strips of the metals to be tested are put into this apparatus and made to vibrate rapidly—thousands of times per minute; the number of vibrations occurring before the strips break indicates the relative strength of the metals. The number of vibrations a strip

can stand is directly related to the rate of vibration; for the rate affects the degree of recovery possible between vibrations. A single long rest period is also an aid, enabling a strip to stand a higher total of vibrations than it can without such a rest period. Strips breaking after vibration, hammering, etc., show very different broken surfaces from those shown by strips broken without such treatment. This is taken to indicate that a decided rearrangement of molecules takes place during action, and that normal arrangements are reassumed during periods of rest. Engineers and motor drivers realize the value of such rest periods for machines in avoiding hot boxes; that such rest periods actually prolong the life of essential parts of the car, engine, etc., is not so generally realized. The value of rest periods for the human machine cannot be questioned. We have always recognized the value of long unbroken rest periods (sleep at night), but recent investigations have proven beyond a doubt the value of frequent short rests in delaying or preventing over-fatigue. The method one naturally pursues when he can control his own time is now scientifically supported and recommended for commercial and industrial life.

Other Likenesses.—There are many other minor likenesses. Accidents cut short the life of but a small percentage of both engines and human beings—less than 5 per cent., probably. Too much inactivity or rest is not good for either, for both rust out. The engine does this literally, but the body suffers the same impairment through the accumulation of fat, the loss of elasticity and adaptability in muscles, heart and other blood vessels. Then, too, engines, like people, always have a weakest spot. There never was a second "one-hoss shay," and the people who likewise wear out all over—who die of "old age"—are almost as rare. Environmental influences are important for both human beings and machines. Excessive dampness and irritating gases may predispose to respiratory diseases and tuberculosis; these same agents may cause rust and corrosion in important parts of an engine.

The body-engine parallel breaks down in two important respects: (1). The engine cannot repair itself. Its fuel is fuel only, and cannot serve as material for growth and repair. While the human body uses foods mainly for energy or power, certain of our foods also supply the essentials for growth and repair.

(2) The second important difference is with regard to bacterial

diseases. Poor construction, poor materials in machines may be likened to weak constitutions, low vitality, etc., in human beings, but there is not a complete parallel for disease, for the machine is not subject to bacterial invasion as human beings are.

Bacterial Action.—Bacteria may invade and weaken any organ of the body; less often they distribute themselves quite generally throughout the body. By their action they interfere greatly with health. They sometimes secrete poisons or toxins which irritate or injure the body; they may decompose our normal foods into irritating or non-nutritious substances; and they may actually disintegrate or destroy tissue, as in ulcers.

The results of such bacterial action are more serious than we realize. We "get well," but that does not tell the whole tale. Occasionally one seems better after an illness than before, due probably to the long rest, better food, or improved care taken during and even after the convalescent period. Quite often, serious effects are more evident and persistent. One's chances for a long and vigorous life are lessened by every illness; for the few who seem uninjured (and we can never predict what their possibilities might have been without the illness) there are thousands who must "walk softly all their days."

Keeping Well.—Keeping well, however, includes more than avoiding infection by bacteria. Such diseases as nervous affections, eye weakness, caisson disease, and pellagra may interfere just as completely with one's happiness and life work as diseases caused only by bacteria. Such diseases and decided predisposition to many other diseases often come from ignoring the laws that apply to man and machines both. Yet, it is not an uncommon thing to find an individual giving more real consideration and more time to the well-being of a motor cycle or a motor car than to his own health or to the health of members of his own family.

This is not intentional, of course. It is because a poorly cared for machine stops running. It won't work. But the body machine braced up by stimulants, helped by high nervous tension, works on until we forget that there *is* "a limit to what flesh and blood can stand."

The body must be fed, exercised, rested, and cared for to avoid any predisposition to disease. Its environment must be made safe and healthful. The environment includes the next-door neighbor

who has smallpox; water from the watershed polluted by the typhoid carrier on a Pullman train; milk from a farm four states away where septic sore throat prevails; the smoky pall in the air which delays the germicidal action of the sun 90 millions of miles away; in fact, as Sedgwick once defined it, "Our environment is that part of the universe that lies outside ourselves." To wholly control such an environment is a mighty task.

Personal and Community Hygiene.—The relation between the individual and the environmental factors that may affect his health are very close and also very far reaching. It is often difficult to say where personal hygiene ends and public health begins. What is a matter of personal hygiene to you individually may become an important phase of sanitation when you are responsible for the health and food of a family or a group of school children. You, from habit, never drink from a public drinking cup; but the removal of public drinking cups from the school attended by your children is a matter of public health or sanitation.

To live up to the implication of the slogan, "Woman's place is in the home," would take her out of it. She is responsible for safeguarding in every way the well-being of the members of that home. She becomes thereby interested in pure water, safe milk, warm lunches for school children, health examinations for the waiters who serve the older boys' down town luncheon, the enforcement of quarantine for the lawless cases of measles next door, the flies in the meat market and the piles of refuse at its back door, the tubercular clerk in the laundry who folds articles ready for delivery, the broken sewer pipe on the hillside within fly-distance of the house, the proposed local enactment requiring health examination for domestic helpers, and the election of the mayoralty candidate who favors school nurses and free school clinics. The hygienic interests of the individual, the home and the community are essentially one and the same.

See Reference List at end of Appendix.

CHAPTER III

FOOD

THE FUNCTIONS OF FOOD

THE bacterial origin of disease is so generally accepted to-day that we find it difficult to realize that there are diseases with which bacteria have little or no connection, *e.g.*, several nervous disorders and nutritional diseases.

Foods an Important Factor in Health.—Do we not dismiss as "all imagination, anyway," the pathetic tales of a "nervous" patient? How many of us realize that our present diet of good, clean, attractive, satisfying food may be—less promptly, perhaps, but just as surely—the foundation of years of illness and discomfort as would food in a nauseating state of decomposition?

We all agree (1) that food should not convey pathogenic (G) organisms (*e.g.*, tuberculosis in beef, butter, milk); (2) that it should not be deleteriously affected by other micro-organisms (*e.g.*, those forming ptomaines (G) in cheese or fish); and (3) that it should not be preserved, stored, or prepared in any way injurious to man (*e.g.*, the copper greening of peas). But it is just as important that our daily food should include the proper proportions of proteins, fats, etc., and absolutely essential that certain foods little valued by the general public (*e.g.*, fruits, milk) should form part of every diet, especially that of children.

That we should "eat to live" not "live to eat" has been the ideal held up to us from childhood. But that is merely a check on the amount eaten; and beyond a few wholly mistaken ideas, such as "fish makes brains," we are very vague about *what* we should eat.

To answer that query we must first know the functions of food in the human body. Ask your nearest neighbor that question and the answer will be "to keep well," "to keep alive," "to make blood," "to keep up our strength," "you can't work without food,"

or a similar vague answer. But which foods are absolutely essential to health, how much food we need to keep alive, or to do the work allotted to us, or what foods should compose the dietary of the growing child, the hard-working adult, or the invalid, are problems most of us never even recognize as problems.

For some years many investigators in chemistry and physiology and the allied sciences of bacteriology and nutrition have worked at these problems, and at last we are near a complete answer to the question, What are the functions of food in the human body?

Functions of Food.—Food serves three general purposes or functions[1] in the body: (1) It furnishes energy. (2) It supplies the material for growth and repair. (3) It regulates the body processes (this last use is illustrated by iron, which is necessary for the formation of hemoglobin in the red corpuscles).

Having stated the three functions of food, it remains to be seen how these three functions are satisfied by the five following divisions of foodstuffs: fats, carbohydrates (G), proteins (G), minerals, and vitamines (see p. 27).

Food as Fuel.—Food supplying energy can be considered as fuel. That it is burned or oxidized in the human body instead of a furnace does not affect the matter at all, except that an appropriate form of fuel must be used. All fuels are primarily carbon compounds, and human beings are limited to such carbon compounds as sugar and fats. and are not able to use such forms as coal, wood, or carbon dioxide.

An engineer knows exactly how much work a given amount of fuel can do. He estimates it by the weight it can lift or by the heat it gives out. We do not find the units of weight (foot-pounds, or horsepower) suited for determining the fuel value of our foods; but measure their relative energy values by heat units, or calories. The following table of 100-calorie portions illustrates the variation in the fuel values of some of our common foods.

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[1] This whole matter may seem to belong to human physiology rather than general hygiene. But so long as one person controls the dietaries of a number of people (*e.g.*, the mother in the home, the manager in the hotel or boarding house), a brief review of foods—their function and their values—should be part of the discussion of home and community problems.

AMOUNTS OF FOOD YIELDING 100 CALORIES

Apple—1 large or 2 medium size
Banana—1
Beets—3
Bread—2 one-half inch slices
Butter—1 tb. (tablespoon)
Cheese—1 slice 2½" × 3" × ¼"
Cornmeal—¼ c. (cup)
Cream of wheat (uncooked)—3 tb.
Dates—4
Dried peas or beans—2 tb.
Eggs—1½
Graham crackers—3 large
Macaroni—¼ c.
Milk (whole)—⅝ c.
Orange—1 large
Peanut butter—1 tb.
Peanuts (whole)—11-15
Potato—1 medium
Prunes—4 or 5
Puffed wheat—1½ c.
Raisins—11
Shredded cabbage—5 c.
Shredded wheat biscuit—1
Sugar—2 tb.
Walnuts—8

Fats.—This difference in fuel value is explained, referring to the next table; notice how much richer butter is in carbon and hydrogen.

Foods	Carbon	Hydrogen	Oxygen	Nitrogen	Available calories per gram
Cane sugar...	42 per cent.	6 per cent.	52 per cent.	—	4
Starch........	44 per cent.	6 per cent.	49 per cent.	—	4
Butter.......	75 per cent.	12 per cent.	13 per cent.	—	9
Milk protein (casein)....	53 per cent.	7 per cent.	23 per cent.	16 per cent.	4

Both carbon and hydrogen unite with oxygen, yielding energy, and butter has about twice as much carbon and hydrogen as sugar, starch, or protein. Butter has also less oxygen and, therefore, has less of its hydrogen and carbon already united with oxygen, so it is, as the table shows, *more* than twice as good a fuel as the other substances. Fat is, therefore, a very compact fuel, and we are all familiar with the fact that fat is a favorite food of those living in very cold regions. It is also a good addition to the diet of those doing heavy work, as it may easily be added as almost pure fat (*e.g.,* olive oil, butter) and give the increased fuel value needed without upsetting the food balance (*e.g.,* adding unnecessary pro-

tein). Fats are less likely to form objectionable products than are proteins and carbohydrates. They do, however, delay the secretion of gastric juices, and grease-covered particles (as in hard-fried foods) may not be properly digested. That excess food fats may be stored in the body is now accepted; but that is no excuse for over-feeding with fats. It is inadvisable to carry about so much "dead weight" of fat; fats in large amounts may induce nausea; there are also individual digestive differences that may limit the use of fats as food.

Recent investigation indicates that some fats have more than their energy value to recommend them. Most fats vary little in their food values or digestibility, but milk and egg fats contain substances necessary for growth, which lard and certain other fat substitutes for butter do not contain (vitamines, p. 27).

Sherman suggests that many people are using more fat than their energy requirement would warrant (less than half a pound per week); he recommends that they consider whether or not some of that money should not be spent for milk. "A pound of butter is equal in energy value to 5 quarts of milk, but in view of the proteins and ash constituents which the milk contains, it would probably be wise to consider that 3 quarts of milk fully equal 1 pound of butter as an asset in the dietary, except perhaps in those cases in which the energy problem distinctly predominates. To pay much if any more for a pound of butter than for 3 quarts of milk will usually mean either that an extravagant price is being paid for butter or that the milk used is below the quality which the consumer can afford and should demand."

Carbohydrates.—The main energy-yielding foods, however, are not the fats but the carbohydrates. Starchy foods, such as cereals, bread, and potatoes, form a large part of our diet, and rightly so; for potatoes and whole-floured cereals and grains contain a favorable proportion of protein and many of them contain those important but mysterious vitamines. Cereal and grain foods as served on the table are commonly 50 to 80 per cent. starch. Sugars alone are credited with supplying one-fifth of our energy requirement. Ordinary cane and beet sugars are practically pure substances and well-adapted for use as emergency additions, as their increase will not require other adjustments of the dietary as would foods which contain protein. As a nation our per capita sugar consumption is

unusually high, 85 pounds per year. The average for the six largest European countries, England excepted, is but 26 pounds.

Those responsible for the feeding of others should, however, recognize the possible evils of overfeeding with sugar. Too high a percentage of sugar is irritating to the mucous membranes; Sherman illustrates this by citing the effect on the mouth lining as candy slowly dissolves in the mouth. Sugar is mainly absorbed in the small intestine; but delay in passing from the stomach or other digestive disturbances may allow the sugar to ferment. This means not only a loss of food value, but causes pain or other discomfort due to the gases or acids formed. Another reason for reducing the amount and concentration of sugar in the diet is that overeating of sweets dulls the appetite, and causes a mawkish feeling, or even nausea. Sugar so affects the sense of taste that the natural flavors of cereals, whole wheat bread, and delicate green vegetables make but little appeal, leading to a lessened intake of the foods often most valuable in nutrition. *Fresh* fruits—to appetites not dulled by sugar—offer a pleasing form of sugar, usually with valuable mineral and vitamine additions.

Carbohydrates are readily stored as fat (and glycogen (G)). If food is in excess of the actual needs, it is probably best, considering the effect of fats upon appetite and digestion, that the excess should be carbohydrates.

Proteins.—Protein foods may be utilized for the production of energy, for, as the table on page 20 shows, they equal carbohydrates in fuel value. Their most important use, however, is as building material: (1) for growth of new tissue (growing child), and (2) for the constant repair of old tissue. For these building or upbuilding processes about 60 grams (about 2 oz.) of protein are needed daily; usually 10 to 15 per cent. of the caloric value of our food should be in proteins. Meat and eggs, the protein foods highest in popular esteem, have proportionately high prices, and most people naturally use as sources of energy the cheaper fuel foods, the carbohydrates. An economical diet, therefore, includes only the necessary amount of protein, making up the required caloric total by the addition of foods poor in or totally lacking protein. If the starches, sugars, and fats are sufficient to complete the total energy requirements, the proteins are said to be protected,

and are wholly available for building purposes; in this sense, carbohydrates and fats are spoken of as protein-saving foods.

All diets do not include sufficient protein. "A quart of milk a day for every child" will insure the necessary protein, as 19 per cent. of the fuel value of milk is protein in easily available form. The dietaries of the very poor and of people with very strong "likes and dislikes" are sometimes deficient in protein. The processes of food preparation reduce unduly the proportion of protein in some of our most important foods, *e.g.*, "polished rice." Fads have been responsible for some cases of underfeeding and malnutrition, especially among children.

Excess Protein.—Since proteins are so essential to health, the natural inclination is to eat plenty of them—to be sure we have enough. Hearty eaters—particularly those who like the physical sense of being well-fed, who want something "to stay-by" them until the next meal, often overfeed with proteins, as proteins are slower in leaving the stomach than carbohydrates. This is not a good plan, for though excess proteins can be used as fuel or, to some extent at least, stored as fat, they are not desirable as the source of either fuel or fat. Proteins are not easily cared for in the body. They entail too much work for the digestive apparatus, and the strain on the excretory organs is needlessly increased.

Lusk states that "meat stimulates the body to a higher heat production, as great as 55 per cent. having been observed in a resting man." This is due to the peculiar character of protein. Since this heat cannot be "utilized in the execution of mechanical work," its production and its elimination are both wasteful processes.

Lusk also adds that the false idea of the necessity of meat has come through the following faulty reasoning: "A strong man can eat more meat than a weak one, hence, meat makes a man strong."

The large number of people suffering from liver and kidney diseases, especially after middle age is reached (see p. 300), when the cumulative effect of such overstrain of the organs might be expected to show up, indicates the need for protein limitation, especially where there is a family history of kidney or liver disease. Proteins are more likely to undergo undesirable putrefaction in the intestines, leading to "auto-intoxication" or other digestive disturbances. With increasing age, the protein limit should be increasingly emphasized, reducing it in proportion to the reduction in

the total calories, as older people are less able to deal with a protein excess.

Almost all authorities recommend a considerable reduction in the meat eaten on economic grounds: (1) The food necessary to fatten the meat-animals could be more economically used directly by man: (*a*) Man could get twelve times the fuel value from the corn represented in a slice of pork that he gets from that piece of pork; (*b*) cows should be used for milk and less for meat, a cow in good condition will give in one year milk containing "as much protein and two and one-half times the number of calories as are contained in her own body."

The use of vegetables as a source of protein (whole wheat, potatoes in their "jackets," unpolished rice, peas, beans) is not only economical but desirable; for in such foods proteins are found in the (10 to 15 per cent.) proportion desirable in the average diet. Such foods are also coarser in texture or contain indigestible residues that have helpful effects: they promote peristaltic action and contain one or more laxative elements that help counteract the tendency to constipation, a condition but too prevalent, and by many explained as due to a sedentary life or to the present too condensed and over-refined dietaries.

The food problems are not settled when one has determined the amount of protein necessary for growth (including repair) and added to it sufficient amounts of fats and carbohydrates to supply the energy requirement. Some foods on being broken up in the body yield acid substances; eggs, fish, and meat are good examples of such acid-formers. The blood and body tissues generally are neutral or slightly alkaline. Acid accumulations from such foods are, therefore, injurious to the body (acidosis) and must be neutralized by alkaline or basic substances. Many other foods—fruits and vegetables generally—yield such basic substances; good examples of such base-formers are prunes, raisins, potatoes, carrots, spinach, celery, rutabaga, beans, and beets. With meat or fish, then, one should eat a sufficient amount of base-forming food, (the acid formed by one hundred calories of meat is neutralized by one hundred calories of potato). Grains generally are acid-formers; rice, therefore, may be substituted for potatoes as a source of energy, but not as a complement to meat to neutralize its acid products.

Minerals.—Another important problem is the mineral [2] requirement. It was formerly thought that a diet filling the protein and energy requirements would provide adequately for the mineral needs of the body. This, unfortunately, is far from true, especially for the essential minerals, calcium, phosphorus, and iron.[3]

The total daily mineral requirement for an adult is between 18 and 28 grams (0.6 oz. to 1 oz.). Dietaries often lack the requisite amounts of one or more of these elements: calcium, for little children if milk is not the principal part of the diet; iron, most essential for growth, though present in the body in very small amounts (less than three grammes or about $^1/_9$ oz.).

Dietaries containing the full minimum requirements for each mineral may be unsatisfactory because of the proportion of the several substances. Overfeeding with potassium causes a sodium or salt craving. Too little salt causes a disinclination for potassium foods, such as potato, which may otherwise be a necessary part of the diet; too much salt interferes with the utilization and absorption of food. A comparison of many dietaries shows that they are quite generally deficient in calorie and in mineral requirements, though they are less often lacking in proteins. Since proteins are usually our more expensive foods, this indicates that the lack is due to ignorance and carelessness, rather than to lack of money. The "margin of safety" for minerals, Sherman warns us, is small, and since there is some doubt that all of them can be taken in inorganic form, as medicines, attention must be given to their presence in our daily diet.

Certain of the minerals are obtained in favorable form and amounts from animal proteins, *e.g.*, calcium from milk and sulphur from eggs. Fruits and vegetables, especially the outer layers, are fortunately rich in minerals.

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[2] The importance of water might well be included here. It is a necessary solvent, for all foods must be in solution before they can be taken into the cells. Its importance as an aid in excretion cannot be overestimated. At least two quarts of water should be taken daily; there is little danger from overdrinking water. There is a popular impression that water should not be taken with meals; it is not harmful unless very cold.

[3] The other important minerals are potassium, sulphur, magnesium, sodium, and chlorine. Some of these minerals are present in the body in striking amounts; *e.g.*, calcium constitutes 2½ pounds; sodium, 1/5 pound; and potassium, ½ pound of the average body weight.

Although vegetables and fruits contain the necessary minerals and in utilizable form, it is sometimes difficult—with present-day methods—to provide the full amount. The common methods of food preservation and our over-refinements of food preparation so generally discard the outer coverings of grains, fruits, and vegetables, that a large part of these minerals is lost. Graham, who advocated a whole wheat flour, warned against such over-refinements, saying that we "might discard something of value." We lose, of course, in lump food value by these methods: 100 pounds of wheat yield 100 pounds of graham flour, and but 85 pounds of entire wheat flour, or but 72 pounds of standard "patent" flour. That the difference is used for cattle is little cause for congratulation, when we realize that the discarded 28 pounds contain almost all of the essential minerals.[4]

We have overemphasized the appearance of our foods. In the effort to secure dainty effects we have blindly discarded the nutty brown bread, thinking that the whiteness compensated for the "flat" taste. Our losses are just as great in polished rice, peeled potatoes, pared fruits, and blanched nuts. A little kitchen maid who had peeled the onions and potatoes, shelled the wax beans, peeled the tomatoes, and then peeled the peaches for dessert, was more right than she dreamed when she wished forlornly that "something would grow without skins." To any sensible person so much handling of food is a waste of time; when not followed by cooking, it may be decidedly unpleasant to contemplate.

The importance of such minerals so discarded is shown by the following facts:

1. Mineral salts are absolutely necessary to maintain the normal alkalinity of the tissues.

2. Cell activity (*e.g.*, nervous and muscle irritability) is affected by the mineral constituents of the blood.

3. Resistance to disease is increased (directly or indirectly) by using foods high in certain minerals; *e.g.*, calcium feeding aids in combating tuberculosis.

4. Prolonged deficiency of certain minerals results in such "de-

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[4] Graham flour, not needing the complicated milling processes demanded by "patent" flour, and representing no loss (no part sold at low price for cattle feed), should be cheaper than other flour, not equally or more expensive; this deserves the attention of our food directors fully as much as the price fixing of milk or sugar.

ficiency diseases" as scurvy (potassium), bone-malformations (calcium), and anemia (iron).

5. Certain mineral salts are necessary for growth. Experiments made on rats show that without iron the growth is one-fourth the normal rate.

We have considered three of the necessary factors in any adequate food supply: (1) Fuel or energy foods; (2) proteins for growth and repair; (3) minerals, shown to be absolutely necessary for growth or health. A fourth essential factor remains for consideration—the vitamines.

Vitamines.—The name, *vitamine,*[5] was first used in 1911 for a substance extracted from rice bran in an attempt to find the cause of that nutritional disease, beri-beri, associated with diets of "polished" rice (lacking the outer or bran layers). Similar substances having the power to cure or prevent beri-beri are obtained from yeast, potatoes, meat, and fresh milk. Scurvy, also common among people such as sailors kept for a long time on a restricted or deficient diet, may be similarly prevented by the use of certain vegetables (carrot, potato) and fresh fruits (pineapple, orange, even orange peel). These vitamines are still incompletely known; their presence or absence does not affect chemical analyses of the substances containing them, and they are considered by-products occurring in metabolism—not the results of mere digestion. All that most reliable authorities are yet willing to say is that they are basic nitrogenous substances; that they may be affected somewhat by heat; and that there are at least two vitamines, a fat-soluble vitamine (butter, egg yolk) and a water-soluble vitamine (milk). These are found in the substances already mentioned and many others; including legumes, cod liver oil, etc.[6] The vitamines differ in the amount of heat they can withstand. Pasteurization of milk at the high temperatures formerly used probably deprived milk of this important factor;[7] potatoes may be boiled

[5] The first part, *vit*, was used to indicate its necessity for life; the second part, *amines*, because it was thought related to those nitrogenous substances.

[6] Vitamines are formed in the leaves of plants; it is thought that animals merely "condense" them. The valuable animal sources are milk, butter, and eggs.

[7] For babies orange juice, cereal water or potato water may be used to supply this deficiency.

without losing their vitamine efficiency. Suitable additions to the diet of soldiers and sailors have stamped out scurvy and beri-beri. This indicates that, despite other interesting theories, they are probably deficiency diseases. Pellagra may be added to this class as investigation progresses. Both the fat-soluble and water-soluble types of vitamines studied have been shown, in experimental work, to be essential for growth, as well as health. Not only must diets be balanced along fuel and building lines; they must also contain sufficient amounts of minerals and these as yet unanalyzed and unmeasured vitamines.

Balanced Diets.—" To eat to live " is no simple task, apparently. Diets balanced in regard to these four considerations are not easily planned. " To eat what we like " may at times satisfy cravings that should be satisfied (*e.g.*, the herbivorous craving for salt, which is not shared by carnivorous animals, who obtain sufficient salt from the flesh eaten). It is not a safe rule, however, unless, as Stiles suggests, we " extend the range of our liking." Every effort should be made to develop in children a more catholic taste. There are occasional " food sensitives " who cannot eat strawberries, lobster, milk, or eggs in certain forms, etc. Such conditions may be, Vaughn suggests, the fault of early feeding (see p. 210). True "protein sensitives" are not very common, and most children may safely be taught to like a wide range of foods.

An interesting illustration of a balanced diet is given by Lusk in the peasants of southern Italy, who " live mainly on cornmeal, olive oil, and green stuffs, and have done so for generations. There is no milk, cheese, or eggs in their dietary. Meat in the form of fat pork is taken three or four times a year. Corn meal is taken as 'polenta' or is mixed with beans and oil, or is made into corn bread. Cabbage or the leaves of beets are boiled in water and then eaten with oil flavored with garlic or Spanish pepper."

Corn, lacking one desirable protein, and olive oil, lacking in minerals and vitamines, if supplemented by green leaves which furnish the additional proteins, minerals and vitamines. make a sustaining, balanced diet. (Incidentally, this cheapest of cereals and a cheap vegetable oil cost the Italian peasants but three cents per day!)

Amount of Food Needed.—Having discussed thus briefly the uses of the various foodstuffs, there remains still the important

question, How much of these foodstuffs is necessary for the complete nourishment of the body? The evils of undereating are implied throughout the preceding pages; with lack of energy and strength, lack of storage for emergencies, loss of weight, imperfect growth, anemia, and the other deficiency diseases, must be included the less direct effects of sleeplessness, sensitiveness to cold, and mental depression and irritability. These occur not only in the evidently starving, but in people whose diet is ill-chosen.

Overeating is more common, probably, than undereating. Hunger is not a reliable guide, especially if one eats rapidly. The evils of over-protein feeding have already been discussed. Any form of overeating throws extra work upon the organs of digestion and elimination, leading often to permanent enlargements, degenerative changes, and causing predisposition to disease. Indigestion in its varied forms, liver and kidney diseases, gout, arthritis, some forms of eczema, and a general disinclination to mental and physical exertion (especially in the very obese) are evils not measurable in terms of gastronomic pleasures.

How much we shall eat is a very important problem. It is so comprehensive that we cannot do more in a book on general hygiene than state the general conditions and variations. Anyone responsible for the feeding of others should consult up-to-date authorities [8] on nutrition. With regard to this point Sherman gives the following: "If from year to year the body keeps in good condition for its work and maintains a fairly constant weight which bears such a proportion to the height as to show that a proper amount of fat is being carried, it is reasonably certain that the amount (fuel value) of food eaten in the course of the year is substantially that which is suited to the degree of activity maintained. If, however, by following the appetite, one becomes unduly stout or unduly thin, or does not get sufficient fuel for the energy required for the day's work, or is annoyed by digestive disturbances indicative of improper feeding, it is certain that the appetite is in this case not a perfect standard. Still more often will the individual appetite prove an inadequate guide to such a quantitative combination of the different types of

[8] Several give the food needs in ounces, in ordinary portions, or in other easily determined units, *e.g.*, slices of bread, spoonfuls of butter and cupfuls of milk.

food as shall lead to a well-balanced intake of each of the many essential food constituents."

Our highest authorities disagree somewhat with regard to the total amount of food necessary, and the proportion of protein necessary or wise. A fair average is 3000 calories per day for an adult at ordinary labor (2100–2300 for light labor [9]) with the protein forming 10 to 15 per cent. of that total. Even when at rest—lying down or sleeping—considerable food is necessary, about 1650 to 1850 calories per day. The weight of the body must also be considered, for twice the weight means about twice the tissue to be nourished; it also means twice the energy for locomotion. The relative surface has an important bearing, and children (having relatively more surface per pound of weight) have increased food needs.[10]

Convalescents and growing children need more of the building stuffs (proteins, minerals, vitamines) per pound than do adults: their greater activity and the surface ratio just mentioned do not change materially the ratio of proteins to the energy or fuel foods, however. With increasing old age both the fuel and protein needs decrease.

Family Expenditures.—Even though one sensibly attempts to secure a daily balance (not a meal balance) it is far from easy to plan a pleasing and inexpensive dietary for a family composed inevitably of members showing most of the varied conditions just mentioned. A study of the dietaries of many hundred families shows that they tend to spend too much for proteins—and for the more expensive proteins—and too little for milk. Slogans to remedy this defect are coming into use: "A quart of milk a day for every child;" "No meat until three quarts of milk have been bought;" "As much for fruit and vegetables as for meat and fish;" "As much for milk (and cheese) as for meat (and fish)." This replacement of meat by milk occurs in the following percentage dietary for four adults and three growing children recommended by

[9] Mental work, for example, demands little increase in food value; the brain mass is but about 2 per cent. of the whole body mass, and its activity could have but little effect upon the total body metabolism. Emotional expenditures make much greater demands, however, because they affect gland and muscle activities.

[10] Accordingly, a baby one year old needs twice the calories per pound that its parents do.

Sherman; its proportion of fruits and vegetables (as well as milk) also recognizes that our money must buy the essential minerals and vitamines as well as the foodstuffs that can be measured in calories.

M	Per cent. of total cost of food
Meats, poultry, and fish	10–15
Eggs	5–7
Milk	25–30
Cheese	2–3
Butter and other fats	10–12
Bread, cereals, and other grain products	12–15
Sugar, molasses, and syrups .....about	3
Vegetables and fruits	15-18

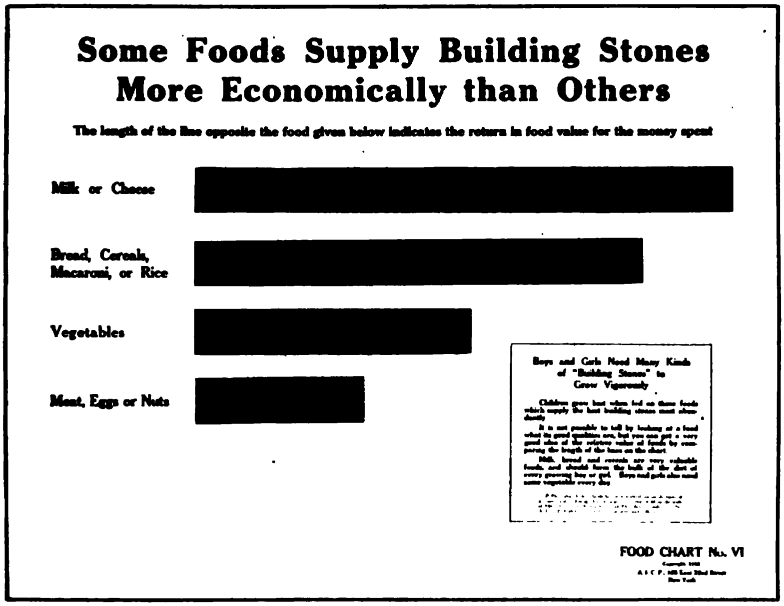

FIG. 14.—One of the food charts issued by the Association for Improving the Condition of the Poor, New York City.

As Sherman points out, there are "large discrepancies between nutritive value and market cost, and correspondingly ample opportunity for the exercise of true economy in the choice of food materials" (see Fig. 14).

The need for economy in peace as well as in war time makes the following rules by Lusk very helpful:

RULES OF SAVING AND SAFETY

1. Let no family (of five persons) buy meat until it has bought three quarts of milk, the cheapest protein food. Farmers should be urged to meet this demand.

2. Save the cream and butter and eat oleomargarine and vegetable oils. Olive oil or cottonseed oil, taken with cabbage, lettuce, or beet-tops, is excellent food, in many ways imitating milk.

3. Eat meat sparingly, rich and poor, laborer and indolent alike. Meat does not increase the muscular power. When a person is exposed to great cold, meat may be recommended, for it warms the body more than any other food. In hot weather, for the same reason, it causes increased sweating and discomfort. In general, twice as much meat is used as is now right, for to produce meat requires much fodder which might be better used for milk production.

4. Eat corn bread. It saved our New England ancestors from starvation. If we eat it, we can send wheat to France. Eat oatmeal.

5. Drink no alcohol. In many families 10 per cent. of the income is spent for drink, or a sum which, if spent for real food, would greatly improve the welfare of the family.

6. Eat corn syrup on cereals. It will save the sugar. Eat raisins in rice pudding, for raisins contain sugar.

7. Eat fresh fish.

8. Eat fruit and vegetables.

A woman to whom the scientific planning of meals is a new thing worked over the problem for awhile, and then said: "It's just like putting together a picture puzzle or a dissected map. You can't ever learn it by heart, though, because the pieces keep changing in size and shape. And you've always got to get them all back in to make the same size and shape picture you had before. The piece that was potato turns to rice, and then you've got to add minerals and vitamines and something to go with the meats, because rice is an acid-former, too. And to squeeze them in, something else has to be changed. Even so, you could fit them all in, if the seasons and markets didn't limit you so. Strawberries would fit here—but they cost fifty cents a quart, and besides, they give John hives. For there are always family peculiarities to consider, and just as soon as you decide that griddle cakes would about fit that place, you remember Aunt Lucy's indigestion. It's all interesting, but terribly hard. Of course," thoughtfully, "if I work at it long enough it would be hard still, but it might be terribly interesting."

PROBLEMS

1. An average person (150 pounds) uses 70 calories per sleeping and 77 per waking hour. Compute the 24-hour needs of one who works 8 hours at work demanding extra calories per hour: typist, 25; housemaid, 80 to 150; laundress, 125 to 200; tailor, 45; shoemaker, 90; carpenter, 100 to 160; stonemason, 300; and sawyer, 375.

2. Americans eat twice as much meat as the French and one and a half times as much as the English. Give three reasons why we should change in this respect.

3. A carpenter is supposed to need 3100 calories a day, a shoemaker 2510. If circumstances should confine them to milk alone for a temporary diet, how much milk would each need?

4. A person of average weight uses 175 calories in walking three miles per hour. If he walks nine miles at that rate, how many calories does he use up?

If his food costs two cents a hundred calories, would it be cheaper for him to pay the five-cent trolley fare or buy the extra food needed?

ADULTERATION OF FOODS (AND DRUGS)

A dozen years ago the United States passed a Pure Food and Drugs Act which deals mainly with the adulteration of foods. How necessary such a ruling was is indicated by the percentage of adulteration reported at that time by three of the various food and drug workers in different cities. One found

40 per cent. of over 700 samples adulterated; another
41 per cent. of over 500 samples; and a third
60 per cent. of over 500 samples.

Adulteration Defined.—Adulteration is defined in several different ways in this Act:

(1) "If any substance has been mixed or packed with it to reduce or lower or injuriously affect its quality or strength."

(2) "If any substance has been substituted wholly or in part for the article."

(3) "If any valuable constituent of the article has been wholly or in part abstracted."

(4) "If it is mixed, colored, powdered, coated, or stained in any manner whereby damage or inferiority is concealed."

(5) "If it contains any poisonous or other added deleterious ingredient which may render such article injurious to health."

(6) "If it consists in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal or one that has died otherwise than by slaughter."

Following is a list of adulterations, which belong under one or more of these six headings. Just where, it may interest the reader to decide:

Substance	Adulterant	Remarks
Cocoa or chocolate	Cocoa shells	
Maple sugar	Glucose	
Oleomargarine	Coloring	Sold as butter
Flour	Talc, gypsum	
Olive oil	Corn oil, cottonseed oil	
Gum drops	Paraffin	
Sausage	Cereals	
Cane sugar	Saccharin	A coal tar product (sweet, but lacking food value)
Candy	Clay or "terra alba"	
Whole milk	Skim milk	
Cream	Gelatin	
Chocolate	Cocoa butter subtracted	
Green peas	Colored by copper sulphate	
Jellies	Turnips, squash	
Tea	Once-used tea leaves	
Cheese	Lard,[11] bean meal, potato, bread	
Coffee	Cereals, acorns, date-pits, red slate	
Condensed milk	Cane sugar added to replace fats subtracted	Less suitable for infants
Whole coffee beans	Molded cereal paste	
Special coffees	Caffein extracted	
Cocoa	Starch, clay, brick dust, mutton oil	
Molasses	Glucose	Lightens color to higher grade appearance
Honey	Glucose with pollen	Pollen is found in bee-collected honey
Flour	Alum, nitrogen peroxide	Passes as first grade; flour retains poisonous nitrogen compounds
Nuts and fruits	Whitened by sulphur fumes	Injurious sulphur compounds retained by fruits, kernels
Milk	Formaldehyde	To defer souring

[11] Lard is the only common adulterant in this country; it would seem as if the labelling of cheese should be more definite.

Substance	Adulterant	Remarks
Oysters	Fattened in water containing sewage	
Figs	Worms and their wastes	These worms are larvæ of insects which fertilize the fig when they come to deposit eggs
Meat	Chemicals, such as saltpeter	To bring back red color
Table salt	Starch	To prevent caking
Meat extracts	Plant extracts	Though cheaper, some plant extracts (*e. g.*, yeast) add valuable vitamines, yet they are considered adulterants unless properly labelled

Butter Substitutes.—Oleomargarine is, according to the United States rulings, the term to be applied to butter or substitutes for butter containing fats other than cream. Numerous other fats are used in such butter substitutes: beef suet, lard, cottonseed oil, nut oils. The prejudice against the use of such oils or fats is most unreasoning and unreasonable. In forms other than butter, for baking and cooking especially, they have found their way into all homes; and the people expressing the most vigorous disapproval are probably placidly using the same oil in salad dressing or in cooking. They are as wholesome (see p. 27) and as easily digested as butter; these substitute fats and oils are collected and refined in a much cleaner way than butter fat usually is; they usually decompose less rapidly, and differ from butter not in being artificially colored, but in needing a little more coloring to give the customary appearance. The only legitimate reason for objection is that they are sold as butter, coloring tending to help deceive. The remedy found in our present pure food law demanding a correct statement on the label for all foods sold in interstate commerce does not protect the consumer against such adulterated foods if produced within his own State. The old ruling prohibiting the sale of colored oleomargarines without a license serves no good purpose now, but only tends to keep up the price of both butter and its substitutes.

Drug Adulterations.—In drugs the worst possible adulteration has been found. Soon after the passage of this food and drugs act, one firm was convicted of adulterating two drugs sold in pow-

der form, in which one powder was composed of ground-up olive stones and the second of finely-pulverized burlap!

Alcohol.—Large amounts of alcohol have been sold as medicines; soothing syrup, cold mixtures, headache medicines, and tonics have often covered a brisk sale of spirituous liquors—and the unsuspecting, as well as the confirmed alcoholics, have been injured thereby.

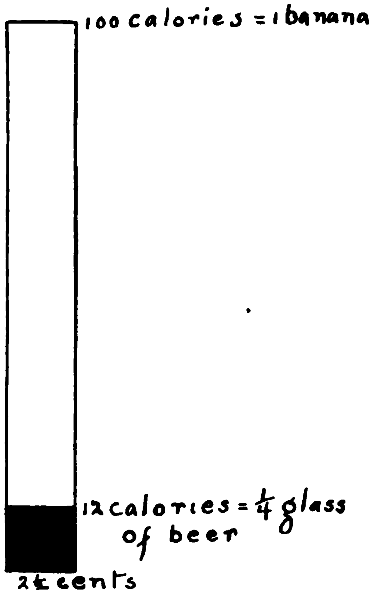

FIG. 15.—To offset the "drug" character of alcohol, some advance its food value. This figure shows it to be a very high-priced food.

That alcohol has a slight value in calories (Fig. 15) has been used as an argument against classifying it as an adulterant (*e.g.*, in candies) or as a harmful drug (*e.g.*, in patent medicines, some of which, before the present laws, were 66 per cent. alcohol). Though this may seem primarily a question of personal hygiene, its relation to community interest is obvious. Alcohol predisposes to such industrial diseases as lead poisoning; it increases the accident list (accident policies are not paid to claimants shown to have been intoxicated); it increases the susceptibility to general disease (life

insurance rates are sometimes increased for alcoholic risks); it is the greatest source of misery (moral, social, and economic) known to the world. It increases the crimes against property and individuals, including illegitimacy, non-support of dependents, and the perpetuation of feeble-minded, insane, and diseased offspring; all this makes it in every respect a community problem. Someone has said that if alcohol were a new synthetic drug introduced from abroad, its importation would long since have been forbidden.

Now the percentage of alcohol and similar irritants and poisons must be printed on the label of patent medicines and similar preparations. (Certain drugs it is, of course, still impossible to buy without the necessary physician's order.)

Labels.—Many of the adulterations of the types listed in the table on page 34 are not illegal, if the label indicates the fact and the amount of adulteration. A little search among the package articles sold at your grocer's will reveal such labels as these:

Apple Jelly (containing 12 per cent. glucose)

or

Citro—Marmalade (containing .1 per cent. benzoate of soda)

Injurious Adulterants.—The government has not fully protected its people, if correct labels are the only thing insisted upon. The unscrupulous hotel keeper or boarding house manager might use inferior food or food containing injurious preservatives, while charging for safe, first-rate materials. Or the ignorant and illiterate might use objectionable preservatives in one or more foods for a long period without knowing the cumulative effect of the chemical thus eaten.

The pure food and drug laws are meant to insure three things:

1. The nutritive value the name indicates (*e.g.*, sugar and not non-utilizable saccharin);

2. Full money value (*e.g.*, meat and not cereal in sausage);

3. Absence of deleterious substances of several types: (*a*) injurious bacteria, such as tuberculosis in meat; (*b*) decomposition

products formed by bacteria and other micro-organisms; and (*c*) harmful drugs, used to cover, delay, or inhibit beginning decomposition.

Difficulties in Interpretation.—The difficulties met in interpreting the provisions of the food and drug regulations act are unguessed by most of us. Some of these may be briefly described:

1. Decomposition is but a relative term: a stage objectionable in one cheese is the one most desired in another; meat that has spoiled for one person is but "gamy" to another who prefers having his domestic fowls suggest the ranker flavor of a favorite game bird. Other foods sold in the sour-krout stage would be thrown away uneaten.

2. Chemicals harmless in large amounts may be harmful in small amounts if taken continuously. To illustrate: rather large amounts of lead (*e.g.*, sugar of lead) may be taken in a single dose without harm, as most of it is eliminated and but a tiny part absorbed. But if that same dose had been given daily in minute amounts, it would all be absorbed and serious lead poisoning would finally result.

3. Chemicals harmful in large amounts may not be harmful in small amounts. For example, the strong poison, hydrocyanic acid, is harmless in small amounts, because it unites with sulphur, making a harmless sulphur compound. Benzoic acid, hydrochloric acid, table salt, and probably alcohol and acetic acid are similarly poisonous in large amounts, but comparatively harmless in small amounts. While it is probable that most poisons fatal or injurious in large amounts are also dangerous in small amounts, if continued long enough, the second and third difficulties make decision regarding certain drugs very difficult. That a feeding squad did not show for a given chemical any evil results in several weeks or even months does not positively indicate what the cumulative effects for a lifetime would be. Much of the recent discussion regarding the use of certain chemicals, such as benzoate of soda, as food preservatives has been due to honest differences of opinion based on just such difficulties as the last two.

Part of the difficulty could be solved by considering, instead, the *reason* for the addition of such chemicals. The general success of the housewife in canning and similar methods of food preservation, shows that commercial processes, with their efficient apparatus, do

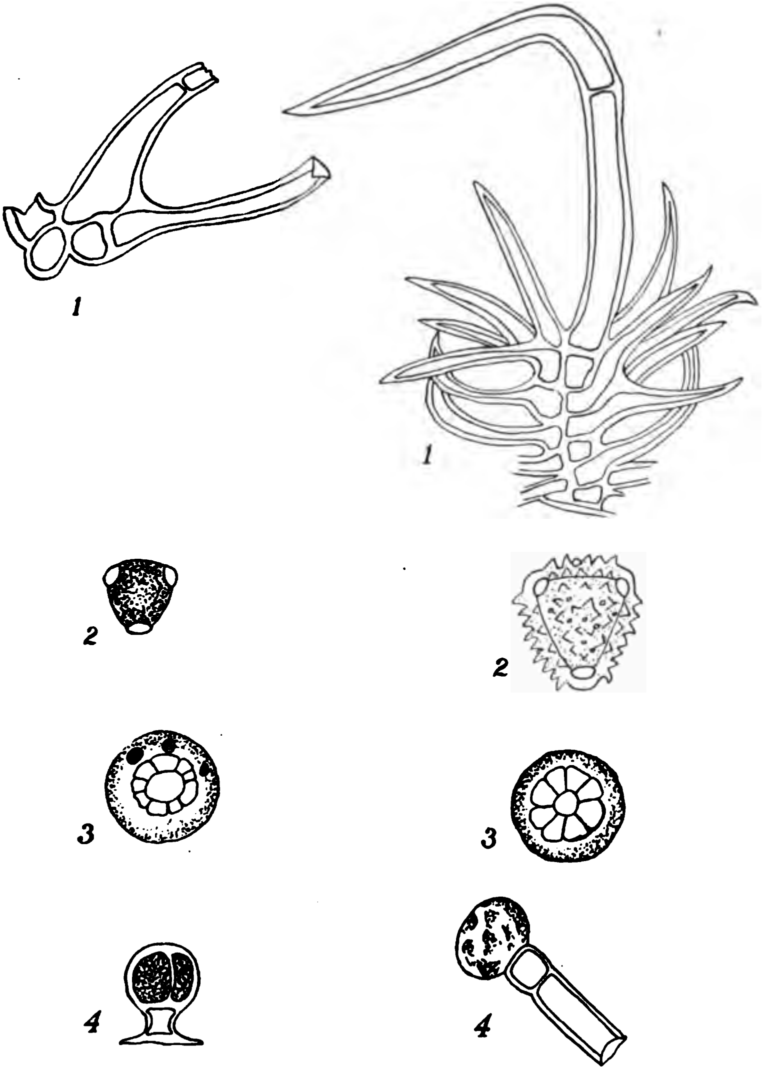

Fig. 16.—Adulteration of drugs is often detected by the microscope. The left-hand figures show typical parts of true horehound. 1, flower hairs; 2, pollen grains; 3 and 4, glandular hairs. Characteristic parts of false horehound are shown on the right.

not *need* to use such preservatives to make foods keep. *If,* as often happens, these preservatives are used to mask poor material, to remove signs of decomposition (to harden fibres and tissues, to brighten the changing color), the consumer is paying for first-class material and receiving third-class substitutes—losing usually in both money and nutritive values.

Methods of Proving Adulteration.—A fourth difficulty is sometimes found in proving the type or amount of adulteration. All kinds of aids are utilized by the government experts; and while

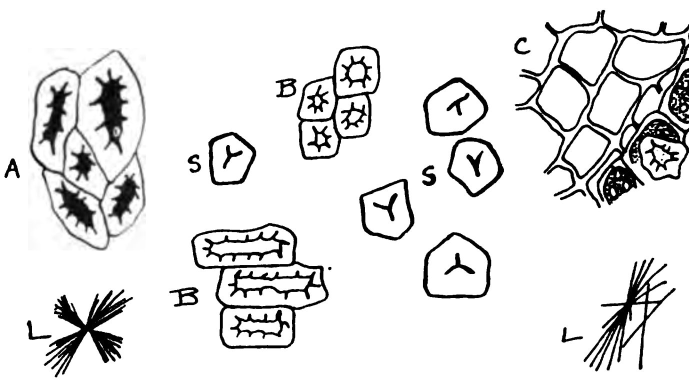

FIG. 17.—That this sample of pepper contained foreign or adulterating material was shown by the microscope. B and C are characteristic cells of pepper seed coats and hulls; but A is from the stone of the olive, S is corn starch, and L shows calcium sulphate crystals.

a detailed knowledge of chemistry is often absolutely necessary, there are many tests so simple that a high school student could use them. For example, starchy materials are often used for adulterating cocoa and coffee; starch turns blue in the presence of iodine, and weak dilutions of starch-containing substances, especially if boiled, will give a blue to black color when iodine is added. Sometimes the simple question of the solubility of a substance—soluble or not soluble—in water or in alcohol proves the presence or absence of adulteration. The microscope is, for many substances, the simplest way of settling the question of adulteration. The cells composing plant and animal tissues have their characteristic shapes, sizes, markings, or contents. Some of these are so marked or con-

stant that a bit of crushed leaf will not fail to show the star-like hairs that cover the leaf surface, or ground seeds or stems of a given plant will always contain cells or crystals of a certain shape, granules of unmistakable contour, etc. (Fig. 16). The accompanying illustration shows varied types of cells found in one sample of black pepper which came from the sources indicated and are never found in pepper (Fig. 17). The specific gravity of substances is easily determined and has proven a helpful guide. Boiling and freezing points vary with salts, etc., in solution, so tests of that kind are often used to see whether valuable substances have been subtracted or undesirable or cheaper ones added to increase bulk or weight. The polariscope [12] is also useful.

Chemicals Not Necessary in Canning Processes.—Claims often made by commercial food producers to justify their use of chemicals in food preservation are (1) that the same process has long been used in the home, *e.g.*, greening pickles in a copper kettle; (2) that the same chemical is formed naturally in accepted processes, *e.g.*, formaldehyde in very small amounts may be formed in prolonged heating of sugary substances; and (3) that the same chemical is used in sickness, *e.g.*, salicylic acid in treating rheumatism. As Harrington points out, drugs having a powerful influence for good in morbid states may exert an equal degree of influence for harm in health. We must also remember that the procedure is not designed to benefit the consumer, but the producer; and without legislation preservatives are doubtless added too freely and too little attention paid to metallic poisons. While there is little accumulated evidence that serious illness results from the copper greening of tea and green vegetables, or tin foil wrappers (chocolate, cream cheese), constant use of such substances may have a deleterious effect. Harrington warns against the daily use of soft drinks from bottles having lead stoppers. Tin in poisonous forms is rarely found in foods (see p. 58).

Small amounts of certain preservatives are allowed in dried fruits, such as sulphur for dried apples and creosote for hams.

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[12] It is a special kind of instrument, resembling an ordinary microscope. The substance to be tested is held in a special container, and light passed through that substance shows certain changes in direction. This deflection varies greatly, for example, in the sugars, varying not only with the kind of sugar, but with the percentage in the solution.

PROBLEMS

1. Has your own city or state any rulings regarding adulteration, labelling and misbranding of foods? Does it compel correct labelling of goods not in "original packages," such as storage eggs, Mocha coffee, arrowroot crackers?

2. Make a list of the articles for sale by your grocer which do give the names or amount of preservative added. The adulterants added.

3. Starch is mixed with yeast to make a drier, better-keeping cake, yet a recent United States ruling makes starch in yeast cakes an adulterant, unless they are so labeled. What do your yeast cakes say?

4. How many of your foods are not protected by the United States rulings? By any State ruling?

5. Can milk be considered as under the interstate law when it is sold outside the State; *e.g.*, from New Jersey farms into New York City? Why does the United States Government not, then, control such milk supplies?

6. The Federal Government considers "widely advertised or generally sold" articles within its province, even though there is no record of interstate sale; support this view. Federal regulations have established for interstate trade the following standard containers: (1) lime barrels, (2) barrels for "fruits, vegetables and other dry commodities," and (3) baskets for "grapes and other fruits and vegetables." The regulations require all packages of food to be marked with their net weights, measure or numerical count. What foods produced in your State and sold in your locality are not similarly protected by State regulations? (Copies of Federal and State rulings can be obtained from the Bureau of Standards at Washington or from your own State departments of weights and measures.) Are you protected against dishonest loose weights by your own State regulations?

7. Many people in New York City have been using with loud praise a pleasant-tasting tooth wash, which the Federal Government has recently investigated and condemned. How can you be sure you, in your State, are not using this tooth wash? Is the Federal Government right in exercising authority over "widely advertised" articles as well as over articles actually in interstate trade?

8. What are the economic losses to the consumer and to the nation resulting from food adulteration?

9. How many patent medicines sold in your town contain harmful substances? Does your State answer questions covering suspected medicines?

10. The United States Department of Agriculture issues periodically pamphlets called service and regulatory announcements. These contain (1) standards to which substances must conform and (2) short descriptions of foods and drugs which they have investigated and condemned. Interesting titles from the 1917 reports are horehound substitutes, tuna fish, beans containing prussic acid denied entry, adulteration of canned pork and beans, and adulteration of condensed milk and misbranding of coca-cola, vinegar, gelatin pills, and rheumatic remedies.

The findings include destruction of adulterated articles, and sometimes fines including costs. Sometimes on filing a bond for a considerable sum, such as $1000, the defendant is allowed to re-label such products properly. Ask your school or library to send for the 1917 and later announcements, and see if you are using condemned articles produced and sold in your State.

MEAT INSPECTION

In the United States (under pre-war conditions) considerably over 100,000,000 cattle, sheep, goats, and swine are slaughtered yearly. Only about 60 per cent. of these are killed in the slaughter houses of firms concerned in interstate or foreign trade, and so come under federal control. Government supervision began in 1906, and over three million dollars are appropriated annually to cover the inspection of meat and meat food products. There are in the United States at least 875 packing houses and several hundred process establishments where meat or meat foods are produced or prepared, concerned in interstate and foreign meat trade and so subject to federal inspection. Some idea of the amount of work done by the federal government is gained on reading that inspection is conducted in 244 cities, and that the total number of meat and meat food establishments inspected is over 3000.

Adulteration.—Regulations concerning adulteration are mainly limited to such restrictions as the following concerning meat food products: sausage must not contain more than 2 per cent. cereal or more than 3 per cent. water, unless it is labelled "sausage and cereal and water"; chemicals used for color changes, as in corned beef, are limited in kind and in amount; the substitution of veal, tuna fish, etc., for chicken must be indicated by the label; and the various extract products (*e.g.*, meat juice, meat extract,[13] and fluid meat extracts) must be labelled to conform with the percentage of total solids, and to indicate such additions as table salt and plant extracts.

Reasons for Federal Regulations.—These regulations are mainly designed to protect man against pathogenic or destructive organisms. Such organisms may cause definite disease in man or they may injure him less directly by causing decomposition changes in the meat.

The bacterial diseases which may be transferred to man through meat eating are mainly glanders (horse [14]), tuberculosis (cattle,

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[13] Extracts have little food value. Most of the protein is left in the residue, the protein in the extract never exceeding 7 to 13 per cent. They are stimulating rather than nutritive. The popular bouillon cubes are commonly 50 per cent. to 75 per cent. common table salt. Plant extracts are sometimes present as adulterants; they may be valuable as sources of vitamines.

[14] At present (May, 1918), horse meat is being sold in New York City. About twenty-four horses a week are sold in one section of Brooklyn; in that section there are nine stores selling nothing but horse meat.

swine), anthrax (cattle), and foot-and-mouth disease (cattle, sheep). Some authorities look with suspicion upon Texas fever (cattle). Malta fever in goats, which may be transmitted to man, is not common in the United States. Other disease-causing organisms which are transferred to man from affected cattle are tapeworm from cattle and swine, and trichina from swine.

Other organisms which do not cause definite diseases in the animals themselves, though they may be constant inhabitants of the alimentary canal, may cause disease in man. The most widely known organisms of this kind are *Bacillus enteritidis, B. paratyphosus,* and *B. botulinus* and the relatives of *B. coli.* Such organisms may get on meat handled in an unsanitary way (*e.g.,* killed in rooms containing live animals or soiled with animal excreta, or by contact with flies or rats from cattle pens or refuse heaps). These organisms usually cause intestinal disturbances, either because of their multiplication in the human intestine, *B. enteritidis* and *B. paratyphosus,* or because they form poisonous substances, true toxins (G). True toxins are formed by *B. botulinus* (botulism). All the above effects were formerly loosely termed "ptomaine poisoning."

While, as just stated, these poisonous substances usually cause stomach or intestinal irritation (vomiting, diarrhœa), their effects vary somewhat with the individual, and may be manifested in heart or nervous derangements, including dizziness, delirium, partial paralysis, collapse or death. Such disturbances are more common as a result of eating veal, fish, poultry or oysters, though they may be caused by pork or mussels.

Cooking often destroys the accumulated poisons. Veal, pork, and fish should always be well cooked. Those cooking their oysters often escape. Suspicious-looking or bad-smelling meats, fish, etc., should be avoided, as cooking is not a positive safeguard.

Bob Veal.—Very young veal is commonly spoken of as "bob veal." The maximum age of calves described by that term is 4 to 6 weeks. Many claim it is dangerous to eat veal of that early age, though there seems to be no chemical or other test to distinguish bob veal from older veal. Experiments by Fish at Cornell University in which very young veal was given to people varying in age from three to seventy-five years, indicate that the meat of sound calves is not harmful. The ages were kept secret, and the recipients voted on the respective qualities of the meat given them at varying intervals, and the heaviest vote fell to three-day old veal! This is sup-

ported by later work by Langworthy and his associates. In Europe bob veal is not looked upon with suspicion. Veal decomposes more readily than beef. Young calves are often infected with diarrhœa and other infections. The difficulties experienced in eating bob veal, or even older veal, are probably due to these conditions. The age at which a farmer is allowed to sell his calf affects the milk production directly. It is, therefore, important economically that the value of bob veal should be recognized.

Storage.—If the meat is kept below freezing, little bacterial invasion and decomposition [15] can take place. Meat is, therefore, rushed through the preliminary processes as promptly as possible, and in large packing houses the carcasses may reach the chilling room within half an hour after the death of the animal. It is later put into cold storage vaults and kept until sold or used (see p. 53).

Regulations.—The regulations aim to insure safe meat to the consumer. They are framed to eliminate diseased meat, to avoid the infection of good meat, and to prevent breaking of these rules by unreliable producers. Among the many regulations are the following: No animals must be killed before the United States inspector is ready for inspection; the inspector must be admitted at any hour of the day or night; suspicious carcasses must be shunted off out of the regular line of animals [16] and specially examined at the end of the day, to avoid contaminating knives, etc.; condemned carcasses must be taken at once to receptacles where they are treated with hot steam until they are unfit for food, or must be dumped into tanks for making fertilizer, etc.; before the carcass is passed by the inspector, organs likely to show infection are specially examined, *e.g.*, lungs and the glands near the intestine for tuberculosis. Knives used on suspected carcasses must be sterilized with hot steam before

[15] While most of us rarely get meat in an advanced state of decomposition, the following characteristics given by H. B. Wood may be helpful. Spoiled beef is wet, flabby, pink or purple (iridescent lines in beef do not denote decomposition), with a distinct foul odor; spoiled veal is soft, mushy, sticky, with a very red tinge, the fat grayish lead color; the fat of spoiled pork is soft and yellow, not pure white; stale poultry is flabby, bluish-green on the crop, the skin is easily pulled apart, and the abdomen has a bad odor; fresh fish have red gills, moist bright scales, clear eyes, and firm rigid bodies; and shellfish shells should close when touched or put into water.

[16] The large animals are all dressed, etc., while suspended from overhead tracks or runways. No animal can be taken from the isolated suspect runway without the inspector's permission.

being used again; passed carcasses must be stamped plainly, "U. S. inspected and passed," and condemned meat must be marked, "U. S. inspected and condemned," or made unsalable by strong dyes, etc. Meat products (lard, oleo, sausages, casings for ham or sausages, etc., made from intestinal membranes, etc.) must be produced under the same sanitary restrictions as the meat itself.

The building itself must reach certain sanitary standards, and the necessary permit will not be supplied to firms who do not reach a minimum standard with regard to the lighting, plumbing, running water of good quality, water wastes, hot water for hand washing, toilets, dressing rooms, clean clothes for workmen, appliances for sterilizing buckets, wheelbarrows, knives, tanks, etc., accumulations of refuse, etc., and the control of dogs, rats, flies, and other vermin. The regulations are detailed enough to include such dangerous but all-too-common practices as holding meat skewers in the mouth.

Interstate and Foreign Control.—Railroads, ferries and other interstate conveyances are not allowed to pass meat without a government certificate or showing the government stamp; vessels carrying animals or meat cannot clear for foreign ports without a federal certificate. All meat sent to foreign ports must come up to the United States standards, unless it is specially prepared according to specifications issued by the foreign buyer, in which case it must conform to the requirements of the country to which it is sent.

Conditions Abroad.—Abroad, many of the customs and regulations are apparently less rigorous than full protection would warrant. Animals "dying naturally" are the perquisite of herders (*e.g.*, in Scotland), and strange to say, little trouble from such meat is reported. Fish causes more poisoning abroad than in this country, partly because more fish is eaten raw, and partly due to the custom among dealers of keeping fish alive in small tanks, probably. Then, too, ice is less generally used abroad; it is no uncommon sight to see street counters covered with flat trays of various kinds of fish exposed without ice or covering in the hottest weather. Over these the attendant occasionally turns the hose, thus distributing any decay organisms that may chance to be present. Fish that crushes between the fingers is not safe, but danger may attend less complete disintegration (see footnote, p. 45).

The United States System.—The United States has a very

good federal system of meat inspection. Recent unjustified statements have tended to discredit it. Some of these were made by a few ignorant persons seeking self advertisement at the expense of their own country, and derogatory statements concerning the inspection service which got into print were afterward retracted by such self-advertisers or proven untrue in courts of law. The contradictions, unfortunately, were not so widely circulated or read. The second set of derogatory statements originated in Germany some years before the war in an effort to keep out American meats, and so placate certain agricultural interests which had previously been treated poorly in other legislative enactments in Germany. Under pretense of tuberculosis and trichina dangers, the importation of American meats was reduced to a minimum. The actual figures disprove the contention, however. Out of over 8000 American cattle slaughtered and examined at Hamburg but 4 were found to be tubercular, while out of the same number of native German cattle 640 were found to be tubercular! In the fifteen years following the exclusion of American pork, there were in Prussia alone over 3000 cases and over 200 deaths from trichinosis, 40 per cent. of which was traced to animals declared free from trichina. At that same time in the United States trichinæ were found in but 2 per cent. of over 2,000,000 hogs, and the total of human cases collected for 30 years amounted to but 900 cases! Also, all the figures available indicate that meat raised in the United States is remarkably free from tuberculosis when compared with European cattle, where the figures in many of the European countries show from 25 to 50 per cent. to be tubercular. This relative freedom from tuberculosis in the United States is supported by the high repute still attaching to tuberculin tests (G) for cattle.

Experienced veterinarians, such as Moore, who are familiar with meat inspection here and abroad, state that we have by far the best system of meat inspection. The one change they all suggest is less rigid condemnation. Diseased areas might be removed and destroyed, leaving much meat safe for human consumption. We wholly condemn, however, a large number of animals[17] yearly a good part of which might be sterilized and sold as second-grade

[17] In 1916 the United States inspectors inspected and passed about 62,000,000 animals; the condemned animals numbered nearly 275,000. The Federal inspectors also condemned on reinspection nearly 18,000,000 pounds of meat or meat foods, because they were soured, tainted, etc.

meat. It would be a little tougher, a little less attractive in color, but safe. Much of it might be made up into chopped meat compounds, such as mince meat, nut-meat loaf, etc. Much meat, such as hams, and meat foods, such as sausages, are condemned on the reinspection given them. We do not realize how complete the inspection is. The animals themselves are subject to inspection on the trains or in the stock-yards; they are inspected during the killing process; meat made up into meat foods is inspected in the establishment where that is done, and the finished products are inspected. Such goods are inspected when shipped, and on their arrival at their destination. Meat crossing State lines may be shipped in bond to its final destination, *e.g.*, New York City, and be examined there as unloaded.

State Regulations.—There are, however, two great needs regarding meat inspection that are the immediate concern of every individual. The State regulations regarding meat are most unequal. Some States have none at all. As stated elsewhere, this means that any diseased animal may be killed for food. It also means that such States are eating meat the Federal Government will not let them ship to other States. No one would like to think he was eating meat not fit to sell to other people! Every State should adopt a meat inspection law, using the United States regulations as a model.

Municipal Regulations.—The second need is with regard to municipal regulation. Some cities, such as New York City, are adequately protected, having regulations equal to the federal regulations. Every city and every other small community should demand that all animals (except possibly fowls) killed for food should be killed in a municipal slaughter house. An inspector should be in attendance whenever killing is done. The building should be rat-proof, screened against flies, and have all the sanitary arrangements already discussed. The disposal of refuse should be properly attended to—burial or burning being the simplest for solids, while blood and water should be carried off in a closed sewer system or disposed of in a sub-soil drainage system (see Sewage Disposal Chapter VII). Such fees as 60 cents for a beef, 30 cents for a hog, have been found feasible.

Other Methods of Killing.—It is expensive to slaughter the animals in different ways, so in localities with a large Jewish

population the large supply houses commonly kill all animals by the Jewish method. In this method the animals are not stunned in the usual way, but are first suspended by a hind leg, and then the throat is cut as the animal hangs head downward. The aim is to secure complete drainage of blood from the body. This method was necessary in the old Mediterranean home land, for bacterial decomposition would progress less rapidly in the drier tissues; it is not necessary, of course, with the present cold storage facilities, and a general adoption of the method in which the animals are first stunned would appear more desirable. There seems to be no good reason why this change should not be made, as the Jewish custom of killing chickens does not include bleeding; through a cut in the neck the windpipe is drawn out, causing suffocation.

So many of the ancient Jewish customs have been found to have strong bacteriological support that it is hoped that these particular methods will soon be changed.

Other Foods to be Handled Like Meats.—The regulations that pertain to meats are generally applicable to fish, shellfish and eggs. Fish has been the cause of paratyphoid infection (p. 44); in one epidemic at least the direct cause was the infection of the fish by a paratyphoid carrier. The federal pure food laws here, too, protect indirectly in interstate trade, under the heading of food unfit for human consumption. Fish has been already mentioned (pp. 45 and 46); the other two classes are discussed briefly below.

Oysters.—Oysters and other shellfish are sometimes dangerous foods. Typhoid is the most common disease traced to oysters; Jordan thinks the danger from this source has been exaggerated. Since bacteria tend to die off in winter weather, both in the oyster and in the surrounding water, we have the popular saying, "Eat oysters in the R-months only." Undesirable bacteria may enter the oysters from the sewage-polluted waters in which they are grown or stored. When oysters are placed in fresh water, they absorb water rapidly, causing the more delicate tissues (*e.g.*, gills) to look swollen or fat. Careless dealers sometimes fatten oysters in any convenient tank or body of fresh water, without considering the conditions. Bacteria, such as typhoid and *B. coli*, may multiply rapidly in warm tanks, or sewage-polluted rivers. One oyster collected near a sewer-outlet contained 17,000 typhoid bacteria. If undesirable bacteria are present, they are

found in the liquid and in the delicate gills and shell membranes as well; they often invade the more solid parts also. Pouring off the liquid simply reduces the amount of danger; it does not remove all danger. Cooking oysters sometimes destroys the dangerous condition. In epidemics of oyster "ptomaine poisoning" those cooking their oysters often escaped poisoning.

Chickens and eggs have also their special problems. They may be discussed here, as cold storage is the only widely used method of preservation for either (see p. 54).

Chickens in cold storage may undergo bacterial changes chiefly because of the invasion of bacteria from the alimentary canal. This may be drawn out by a hook made of wire (wire-drawn chickens), or the body may be cut open in the usual domestic way of "cleaning fowls," and the intestines, etc., removed. Both ways break the alimentary canal and allow the escape of bacteria. Most chickens sold from cold storage are undrawn, the dangers of bacterial invasion being less through the uninjured alimentary canal than from its broken ends. Farmers often keep chickens shut up a day or two before killing them to allow the intestines to become empty. Feeding with sand, sawdust, etc., is recommended as having even a better cleansing action, but such treatment does not seem to be very general.

Eggs are far from bacteria free. Bacteria enter while the eggs are still in the oviduct, and the forming shell encloses them. Eggs may also be infected through the shell (manure on surface). It is thought that the natural glossy film on the surface helps prevent the entrance of bacteria, and it is recommended that eggs visually clean should not be washed. Eggs laid in the cooler spring months have a lower bacterial count than July or August eggs; eggs are usually cheaper also in the spring and storage firms prefer to fill their warehouses during April. The bacterial content is lower, and the flavor, therefore, better.

The white part of the eggs has a somewhat germicidal action on bacteria; in the yolk they multiply rapidly. Nevertheless, eggs are much less liable to convey disease organisms than any other food obtained from animals; this is partly due to the fact that there is apparently no hen disease to which man is susceptible.

PROBLEMS

1. What per cent. of the meat sold by your own butcher is United States inspected?

2. Does your State issue a bulletin regulating the cold storage of eggs, meat and fish? Are they enforced in your community? What is the penalty for non-observance of these regulations?

3. Chickens and eggs do not come under Federal inspection regulations, except as canned chicken, dried eggs, or egg powders come under the pure food laws regarding food in packages (labels, preservatives, substitutions, putrescence and decomposition). Does your State protect you in any way from decomposing or objectionable conditions in such foods?

4. Consult the meat inspection regulations issued by the United States Government. (Order 211, Bureau of Animal Industry). How many of the requirements are included in your own State regulations? What can be done to improve your State conditions? Can your institution select one reform and carry it through?

5. Is there a municipal slaughter house in your town or community?

6. What supervision is given the private slaughter houses in your community? What are the standards or regulation you feel to be satisfactory? Which need to be changed?

FOOD PRESERVATION

The hygienic phases of the food problem are not all covered by *national* legislation: the Food and Drugs rulings and the Meat Inspection Regulations. Milk has no definite *national* legislation, but fortunately the standards set by the American Association of Medical Commissions has had some effect upon the various State standards. In this connection it must be remembered that the meat regulations are enforced only for interstate trade, and that in many States the conditions regarding milk are no worse than for meat produced *within* that State.

Most important are the phases having to do with the preservation of foods, including cooking, for temporary preservation is often one of the aims or results of cooking.

Aims.—The recognized methods of food preservation have two main aims: (1) to free food of infectious organisms (*e.g.*, sterilizing tuberculous veal or beef to make it safe as food); and (2) to conserve food, avoiding spoilage which would mean a loss of food value, or the accumulation of undesirable substances.

Our concentrated urban life, the seasonal limitations, and the desire for the best of the foods characteristic of other localities (*e.g.*, tropical fruits, salt water foods) make the methods of food preservation very important hygienic considerations, for food is often transported thousands of miles or stored for months—sometimes years

Methods.—The methods of preservation concern (1) foods which we desire to keep in their natural condition, such as fresh fruits, vegetables, and eggs; and (2) foods often considerably modified in taste, texture, digestibility, bulk, and appearance by cooking, the addition of chemicals, etc. Our interest in the methods is mainly in regard to these latter points and their effect upon the health of the consumer.

Some of the methods are very ancient, and the oldest records show that people dried, salted, smoked, and (in favorable localities) cooled or froze their foods. We will discuss first the methods producing little or no *chemical* change in the foods (*e.g.*, drying); and next those involving chemical changes or the use of chemicals (*e.g.*, pickling).

The details of any method will be included only when they are of general interest or when variations of the method affect the results obtained (*e.g.*, the effect of long and short heating periods upon the texture of canned goods).

Cold as a Preservative.—Cold has attained first rank as a preservative. Rosenau cites an interesting instance—a mammoth unburied by an avalanche in Siberia which was so well preserved that even the soft fleshy trunk remained, and it is said that natives as well as animals ate the flesh thus released from its icy coverings. Parts of the flesh are still preserved in a museum in Petrograd.

Fortunately it is not necessary to have extremely low temperatures to secure beneficial refrigerating conditions; freezing or near freezing are adequate. The range is generally from 5° C. (41° F.) to -5° C. (23° F.). The extremely low temperatures are relatively drier temperatures, and so really less effective in killing bacteria.[18]

Animal parasites, such as trichinæ, are killed by freezing and cold storage temperatures; trichinæ are killed by 10 to 20 days' storage; tapeworms may live nearly 30 days.

The foods commonly preserved by freezing are meat, poultry, and fish. Fish, after freezing, are sometimes dipped in water and refrozen. The outer covering of fish is, of course, waterproof; cut meats would not be improved by such treatment. Spores of molds or bacteria may escape freezing, and bacteria may be found even in the tissues of frozen chickens.

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[18] Dry heat and dry cold are both less efficient in killing bacteria than moist heat and moist cold; the former penetrate the cells less rapidly.

Cold storage temperatures are often not so low as freezing. Fruits, vegetables, and eggs are less palatable or less attractive after freezing. Temperatures just above freezing are antiseptic rather than germicidal, and so such substances as eggs, though kept in cold storage, may have a high bacterial count. Meat and fish, however, may be kept for a long time without noticeable change. Fish kept two years at cold storage temperatures showed no change that could be detected by any chemical tests. The flavor of eggs is not improved by cold storage; but the condition is certainly better than if they were kept for equal periods at ordinary temperatures. Fruits and vegetables do not deteriorate during cold storage.

Prejudices against cold storage are hard to change. People have been known to refuse to eat cold storage fish free from bacteria and decomposition changes, substituting instead cold storage eggs or Hamburger steak, the bacterial content of each often reaching a million per cubic centimetre.

In reality cold storage [19] is the best method of preserving food materials; it leaves the original substance unchanged, adding and subtracting nothing; the original flavor is retained, the texture, digestibility, and nutritive qualities are not affected.

Why, then, this prejudice against cold storage foods? It is because materials taken from cold storage chill the surrounding air sufficiently to cause its water vapor to condense on their surfaces; this water mixes with the juices on the cut or broken surfaces, making favorable food material for bacteria which have survived cold storage, or which may chance to settle there (air currents in dusty stores or streets, or fingers of prospective customers). Decay progresses rapidly under such conditions. In some cases this condensation of water may be prevented by wrapping the fruits in absorbent paper (oranges) or using absorbent material as packing (coarse sawdust for grapes). Meat is sometimes dried a little before cold storage to make a drier covering, less easily penetrated by bacteria.[20]

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[19] House refrigerators rarely even approach cold storage temperatures. Most house ice boxes do not fall below 10° C. (50° F.), and 15° (59° F.) is not unusual in parts of house refrigerators, especially when the door does not fit tightly or is carelessly left ajar.

[20] Country people often keep the cut ends of ham from molding by rubbing a little fat over the cut surface. The fatty film is less favorable for mold growth than the moist lean meat surface.

The prejudice against cold storage meats and fish has led retailers to thaw such materials before offering them for sale. Unsold material is often re-cooled. The retailer's ice boxes rarely reach killing temperatures, and meats alternately cooled and warmed are subject to great bacterial change. The practice of thawing meat and fish in water is forbidden in all alert communities; one needs but to think for a minute of the possibilities of bacterial contamination of chicken and other meats one might expect if they were thawed in barrels or tubs of water in such secret places as cellars and back sheds. It is easy to see one should insist on buying cold storage meats in their original chilled condition, and keep them cool until time for cooking.

Another strong argument for cold storage meat is that this process is usually applied to meat coming from a distance, that is, outside the State; such meat, therefore, usually must pass the federal inspection necessary for interstate commerce. Such meat bears the government stamp on all large pieces of meat, which guarantees to the consumer that it came from a healthy animal, killed under sanitary conditions, and found free of communicable diseases (see meat inspection, p. 45).

Cold storage—the simplest of all methods of food preservation—has grown rapidly in public favor. Its general applicability to all foods has led to manipulation of the markets to secure high prices. To meet this some States now limit the length of time certain foods (*e.g.*, ten months for eggs) may be retained in cold storage. This is designed to prevent a storage through consecutive producing seasons and "cornering the markets."

Preservation by Heat.—Canning or preservation by heat was used universally in this country about forty years before refrigeration. The story goes that Napoleon, feeling the need of better food supplies for the army, offered a prize of 12,000 francs for a new method of keeping food which was not based on the use of any preservatives then in use. The prize was won in 1804 [21] by Appert, who, however, used no chemicals at all. His perfected method consisted of heating the cans in boiling water. He wrote a description of his methods in 1811, calling it a "Treatise of the Art of Preserv-

[21] A Swede in 1786 canned vinegar; the keeping power of the canned vinegar was probably due to its acetic acid rather than the perfection of his canning process.

ing Vegetable and Animal Substances." A patent was soon taken out in England for this secret "divulged by a foreigner residing abroad"; and soon (1819–20) the process was in full operation in the United States, for fruits, fish, oysters, etc. Most of the substances seem to have been acid fruits, rather "easy to keep," but corn was successfully canned in Maine in 1837. Canning was done both in tin and glass as early as 1820. A great impetus was given to canning by the army needs in the Civil War, and it has become firmly established as a desirable method of food preservation.

The addition of sugar (jams, jellies, and preserves) increases the keeping power of such canned goods. Most bacteria find it difficult to grow in such concentrated sugar solutions, as water is withdrawn from the bacteria themselves to satisfy the affinity of sugar for water.

Rosenau says that heat and cold are the only proper preservatives. Heat shares with cold certain advantages over other methods. It does change the flavor of fruits and milk somewhat, of course; but since vegetables, meats, and fish are always used cooked, that is of little importance in most canned goods. It has one decided advantage over refrigeration: the bacteria present are usually killed [22] and decomposition products are often rendered harmless. Other advantages claimed for cooking and, therefore, canning are the development of new or improved flavors and increased digestibility (*e.g.*, in starchy vegetables).

Methods of Canning.—There are two main types of canning. The first is practised only in the home, and consists of boiling the fruits or vegetables until the bacteria have been killed (usually 10 to 15 minutes), and putting the contents aseptically into a can which has been more or less completely sterilized with boiling water. If filled to the top, and so enclosing little germ-laden air, the can usually "keeps," either (1) because no live bacteria were shut in the can or (2) because they failed to develop, lacking sufficient oxygen, or were killed by the heat left in the hot material.

In the second type the *uncooked* materials to be canned are put into a clean can, and heated in one of several ways, as described in the next paragraphs. This can is closed except for a small vent hole

[22] Canned goods sometimes spoil, (1) because bacteria (chiefly spores) survive the cooking or canning process, or (2) because the can is not perfectly sealed.

(or loosened cap) for the escape of the enclosed air as it expands by heat. This vent is closed promptly before the can cools; as the enclosed air cools and contracts, a partial vacuum is formed. This explains why glass can tops resist opening and why tin cans look slightly drawn in at the ends. Sometimes the hot air is drawn out of the tin cans, making the space above the contents more nearly a vacuum. Most organisms need oxygen for their development, and the limited amount of air left in the can has a deterrent effect on such bacteria which survive the heating process. (Tin cans are often heated after sealing to make sure they are perfectly sealed.)

The second type, where the uncooked materials are put into cans before any heat is applied, is used commercially as well as in the home. This type includes (*a*) boiling temperatures and (*b*) still higher temperatures, where the surrounding water or steam is heated under pressure.

We will discuss first the cold pack method and the discontinuous method, which use boiling temperatures only; later we will discuss the steam pressure methods.

The Cold Pack Method.—In the cold pack method the cans of uncooked vegetables, etc., are surrounded by cold water in a wash boiler or a similar container. The water is heated and held at the boiling point for a definite period of time, varying from 30 or 40 minutes for some vegetables to 2 or 3 hours for corn. The time depends partly upon the solidity with which the material packs or the rate of heat penetration, and partly upon the resistance of the organisms usually found on the vegetables. (Resistant spore bearers are thought responsible for the difficulty experienced in canning corn.)

The Discontinuous Method.—Discontinuous sterilization is more often practised in the home than in factories. The cans are heated in the water bath as in the cold pack method, for a definite period of time designed to kill all bacteria not in the resistant spore stage. After standing at room temperature the process is repeated the next day, and usually a third time on the third day or at least within a week, thus making quite sure of catching the bacteria in a growing or vegetative stage. This process is rarely used commercially, as it involves too much man labor, and such prolongation of the heating period may make the materials too soft and mushy.

Pressure Methods.—In this method we use steam under pres-

sure, as in the now popular pressure cookers (Fig. 18). In the bottom of these little steam boilers is a supply of water and the jars rest on a framework in this water chamber. The steam is not allowed to escape and the pressure and temperature alike rise until we have a pressure two or more times ordinary atmospheric pressure, and a temperature far above boiling (*e.g.*, 125° C. or 257° F.). Commercial canning is almost entirely of this type, but the steam chambers holding the cans are, of course, much larger than in the pressure cooker, and connected by pipes with the boiler containing the water which forms the steam (Fig. 19).

FIG. 18.—Pressure cookers, lid off in one on right. When in use clamps hold the lid shut and so increase the pressure and temperature. The simplest types of autoclaves for sterilising glassware, etc., resemble these pressure cookers.

Containers for Canned Goods.—Glass and tin have their respective advantages and disadvantages. Glass is heavier, less adapted to shipping and to handling by automatic machinery; the bleaching effect of light is not prevented, and poor qualities of glass may liberate objectionable substances (*e.g.*, fluorides (G), lead). Tin cans are better adapted to commercial handling. If the tinned surfaces are broken, metallic salts may be formed. Acid fruits may attack the tin itself. This is prevented by a special coating or lacquer—more or less a trade secret—which is not necessary in peas

and such vegetables. Practically all authorities agree that harmful tin salts are rarely found in amounts worth considering. Harrington doubts if they even equal the tin worn or scraped off of saucepans and kettles. The popular prejudice against tinned vegetables has little but blind prejudice to support it, and if it is a question of canned vegetables or no vegetables, no one should hesitate a second. Canned meat lost in a shipwreck and found forty-four years afterward was in good condition, and eaten without injury.

Fig. 19.—In commercial canning the cans are put into frames or baskets and heated as in the pressure cooker. Instead of forming steam in each chamber, steam is usually piped in from a boiler in the engine room.

Preservation by Drying.—Drying, the third method of preservation involving little or no chemical change in the substances, may be accomplished at ordinary temperatures, or at the higher temperatures used in canning.

Substances which change in color as they dry are nowadays dried quickly, to lessen these oxidation changes (*e.g.*, browning of cut surfaces of apples). Though not completely dried (25 to 30 per cent. water is left in dried fruits) bacteria do not grow readily in or on

such surfaces. Sometimes substances such as meats are subjected for a short time to a very drying atmosphere to make a very dry surface which does not encourage bacterial development, after which they are stored in the usual way. Milk, eggs, vegetables, and fruits can be dried very readily and with but little loss in nutritive value. Eggs, like milk, may be dried by spreading the egg mixture on hot trays, or on a revolving metal belt from which small brushes collect the dried powder; or the mixture may be sprayed into a heated chamber in such a fine spray that it dries before it falls to the bottom.

Chemicals as Additions to Drying Processes.—Apples and substances which naturally undergo oxidative color changes may be bleached by such substances as sulphur gas; one-half the apples on the market are said to be sulphur treated. Molds and bacteria do not multiply so rapidly on treated apples, the sulphur serving as a preservative. Metallic substances from the drying trays have been reported in dried apples.

In drying meats, smoking is sometimes part of the process; less often salting is combined with the drying process. The meat may be hung over smouldering wood which is giving off creosote, acetic acid or formaldehyde.[23] The interior of the mass, as in meat ground up for sausage, may contain bacteria, and meat poisoning (*e.g.*, by *B. botulinus*, which develops toxins), may result. When whole pieces of fresh meat are dried, this is less likely. Instead of hanging meats over wood fires, much the same effect can be secured by treating the meat with a preparation called "smoke," containing creosote, etc.

Preservation by Chemical Agents or Changes.—Foods are also preserved by methods which depend upon the addition of chemicals, or cause a decided chemical change in the substances to be preserved: fermentation, pickling, and salting.

Fermentation, Salting, and Pickling.—Fermentation, salting, and pickling as preservative processes may be treated together. Foods are sometimes packed in dry salt (2 to 3 pounds salt to 100 pounds cabbage in making sour-krout), and sometimes in salt solution (5 pounds of salt to every 12 gallons of water in making dill pickles). In the cases just used as illustrations the plant

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[23] Beech, hickory and oak are favorite woods; some of the other woods give off turpentine, etc., and are, therefore, undesirable.

juices are drawn out and are fermented by the lactic acid bacteria common in the air and on plant surfaces. In time, the lactic acid accumulated kills the bacteria and prevents further changes in the material, unless objectionable resistant molds develop. These may usually be prevented by a covering of oil or paraffin after the fermentation is completed.

Many vegetables may be satisfactorily fermented in brine: cucumbers, string beans, beets, corn, green peas, and green tomatoes. They have, of course, a slightly acid taste, which is most marked in the corn. If still stronger salt solutions are used, even the lactic acid bacteria cannot develop; in this case we have salting *without* fermentation. This method may be used for greens generally (spinach, dandelion tops, etc.) and for kale, cabbage, string beans, peas, and corn. Before using these are well washed and cooked as usual (sometimes in renewed waters to remove more salt).

If vinegar is used its acetic acid acts like the lactic acid and "keeps" the materials. Sugars and spices may be added to vinegar to increase its preserving power. Materials may be packed in brine first and then in vinegar. In meats, such as ham, salting is followed by smoking and drying. The "cold water canning" of raw rhubarb "keeps" because of the large amount of acetic acid in rhubarb.

The disadvantages of all these methods are chiefly that they change the flavor and make the food less nutritious: the fibers are toughened and some of the proteins are made insoluble; some of the soluble proteins are drawn out by the salt and so lost. The main advantages are that a great deal of material can be preserved with a minimum of time and labor, and that inexpensive containers can be used (*e.g.*, old kegs, butter tubs, and jars lacking covers).

Addition of Chemicals.—The addition of chemical preservatives in all articles of food entering into interstate commerce (or so widely advertised as to render interstate sale probable) is now controlled by the federal government under the pure food and drugs laws. Some States and cities reinforce this by local protective legislation.

Our present methods of food preservation do not necessitate the addition of chemical preservatives in any goods sold in glass or tin containers. Care in drying and final handling makes it possible to handle many substances in oiled or paraffined paper, or tin foil for short periods of time, while substances containing little water may

be kept indefinitely in paper (*e.g.*, coffee), if kept dry. It is only where materials are used slowly (catsup on the table, open kegs of apple-butter in retail stores) that any preservative could be necessary, and the federal government rightly limits such processes as the chemical bleaching of flour and dried fruits, or the addition of chemicals to sauces and catsups, classifying such additions as adulteration. There is no argument for the addition of chemicals to hide the poor quality of the substance: to bleach darker meats to "chicken," to harden the soft, decaying fibres of vegetables, or bring back the color of old meats or spoiling vegetables.

Certain chemicals classed as natural preservatives are used in every home as antiseptics rather than germicidal agents—spices in fruit cake or sausage. Even these must not be used indiscriminately, as some are irritating to mucous membranes and therefore harmful. The most valuable ones are cinnamon, mustard, and cloves, though the last gives little aid in amounts pleasant to the taste. Vinegar, salt, and sugar are other home preservatives.

Certain commercial processes, such as putting a film of gum benzoin on chocolate candy, is even approved. Shellac as coating for candy may be injurious, as it sometimes contains arsenic. Slowly consumed catsups and sauces may be allowed a little preservative (benzoate of soda), as the amount of catsup or sauce eaten is usually too small to make the preservative a consideration.

PROBLEMS

1. Farmer's Bulletin 903 indicates that but one State has enacted laws regulating the quality of evaporated or dried fruits. Is that your State?
2. What foods are kept in cold storage in your State? What regulations govern the temperature used, the time limit?
3. Delaware, Indiana, New York and New Jersey require that the date of entry be stamped on cold storage eggs; Indiana and New York demand also the date of withdrawal; New York and New Jersey limit egg storage to ten months. Are these rulings justifiable? How does your State differ in these respects?
4. Criticise a recent New York State requirement that retail stores offering cold storage foods for sale display conspicuous placards to that effect.

See Reference List at end of Appendix.

CHAPTER IV

MILK

MILK has a double claim to our attention. It is more important and more valuable than any other single food. It is also the source of more disease than all other foods, water included. Therefore, whether our primary interest is infant welfare, the scientific feeding of the community, or decreasing the human death rate, milk is of first importance.

Nutrients in Milk.—As an article of food its value cannot be overestimated. It is rich in the principal food elements, as shown by the following table:

Water	87.1 per cent.
Fat	3.9 per cent.
Protein (casein, albumin)	3.2 per cent.
Milk sugar	5.1 per cent.
Minerals (salts)	0.7 per cent.
	100.0 per cent.

Yet how valuable a food milk is few people realize. The tables of food equivalents which show one quart of milk as equal to eight eggs seem questionable to most of us. Even if we *say* we believe it, how many of us would substitute an eighth of a quart of milk for our morning egg and feel equally well fed? The food value of milk is further realized on studying this next table showing the substances composing the 12 per cent. of solids found in milk.

Butter fat (nine kinds of fats: olein, butyrin, etc.)	3.6 per cent.
Proteins (five kinds: casein, albumin, etc.)	3.8 per cent.
Sugar	4.5 per cent.
Minerals (eight elements usually in compounds —oxides): potassium, phosphorus, calcium, chlorin, sodium, sulphur, magnesium and iron	0.7 per cent.
Total solids	12.6 per cent.

Standards for Milk Nutrients.—The legal standards vary greatly throughout the United States; for example, the requirement for total solids varies from 8.0 per cent. to 9.75 per cent. The U. S. Department of Agriculture standards are briefly as follows:

	Whole milk	Skim milk	Cream	Condensed milk (sweetened)	Evaporated milk (unsweetened)
	per cent.	*per cent.*	*per cent.*	*per cent.*	*per cent.*
Fats	3.25	....	18	7.7	7.8
Solids not fat	8.50	....	....	....	....
Total solids	....	9.25	....	28.0	25.5

Since fats are the substances most often withdrawn from milk by unscrupulous dealers, and since fats are all-important in butter making, these are emphasized in all tests of milk. Because of this, many fail to appreciate the protein value of milk. It is, even to-day, probably the cheapest form of protein except cheese, the very cheapest cuts of meat, and salt fish.

Different breeds of cattle and different individuals of the same breed give milk varying considerably in the percentage of fats and total solids. An individual cow, too, shows considerable variation, depending upon general health, exercise, type of food, length of time since calving, and the intervals between milking. To illustrate, in summer the shorter interval between the evening and the morning milking may give in the morning a smaller amount of milk which may be higher in fat content. The type of milker (treatment or reaction of the cow) also affects the fat content. The last part of any milking yields milk richer in fats; incomplete milking due to ignorance or undue haste on the part of the milker yields milk low in fat value.

The above variations have led many to prefer minimum requirements for the fats and total solids instead of an average which honest milk might occasionally fail to reach. This may lead to a slightly lower milk quality, but it assures the consumer of a definite value for his money, and it avoids completely the unpleasant and often difficult task of proving that low-grade milk has been adulterated by the producer or dealer.

Another reason why milk is such a valuable food is that it is readily utilized in the body. Sherman states that 97 to 98 per cent. of the milk protein is digested and absorbed; milk fats are already emulsified and more readily available than any common food fats, except egg fats. The popularity of milk as a diet for invalids as well as for children is therefore easily understood.

Colostrum.—Just before and after the birth of the calf, the milk (colostrum) differs materially in appearance and quality. It contains dextrose rather than lactose; fats more like the fat of the tissues than of milk. It is higher in proteins and often coagulates on boiling, even though freshly drawn. Its specific gravity is greater, and it may be less attractive in appearance, often yellowish (excess fat) to brownish (red blood-cells) in color. It is sometimes slimy, sticky or stringy; and the odor is "peculiar" or unpleasant, and the taste, salty. While evidently suited to the newborn calf, it is, to say the least, not attractive to human beings. Though not injurious to man, it has a decided laxative effect, and most health authorities forbid its sale (for about 15 days before and 7 to 12 days after the birth of the calf).

Bacterial Changes in Milk.—Its value as a food for human beings makes it also a valuable food for other kinds of cells—bacterial cells, for example; both molds and bacteria multiply rapidly in milk. These organisms break up the foods, forming other substances which we do not ordinarily want in milk: mainly lactic acid from the sugar, and ill-tasting substances from the milk proteins. Such bacterial accumulations may cause unpleasant tastes or odors[1] (*e.g.*, fishy odor, bitter or sour taste); they may change the texture of the milk, making it "crack" or "separate" as in ordinary sour milk, or thicken into a semi-solid or less often a slimy mass. Such changes make milk less appetizing and less desirable as food, less useful in cooking, and often wholly unusable for domestic purposes.

An analysis of about thirty samples of milk averaging 3 to 30 millions of bacteria per c.c. (G), showed five types of bacteria causing such changes: 9–11 per cent. acid-forming (not coagulat-

[1] Milk absorbs odors very readily. These, while not dangerous, may affect the palatability of milk, and should be guarded against. Objectionable odors are sometimes absorbed from manure, ensilage, turnips, or even potatoes, if the milk is left too long near such substances. In the house refrigerator similar odor changes may occur. Sometimes the "fishy" taste may be due to rusty vessels or to remnants of soap powder. Occasionally the odor is due to the cow's food; garlic contains a volatile oil which may be eliminated through the udder.

ing); 12–36 per cent. acid-forming and coagulating; 6–19 per cent. alkali-forming; 14–17 per cent. peptonizing; 29–43 per cent. inert, producing no decided change in milk.

Disease Organisms in Milk.—A second reason why milk is dangerous is that it often carries disease-producing bacteria. Milk is credited with a "greater potentiality to disease" than any other food. Many of the pathogénic bacteria are inert, *e.g.*, tuberculosis, typhoid, paratyphoid, and diphtheria, and their presence is usually wholly unsuspected. Hidden in its milky whiteness pathogenic

DISEASES DEFINITELY TRACED TO MILK

Disease	Treatment of milk	Effect on man
Bovine diseases:		
Streptococcus infection of udder	Pasteurize; discard if abnormal in appearance	Diarrhœa; septic sore throat
Foot and mouth disease	Best to discard	Fever, diarrhœa, skin eruptions, especially in children
Cowpox	Do not use	Smallpox in man
False cowpox	Pasteurize; milk may be safe, if no exterior pus enters	Not transmitted to man
Anthrax	Do not use; spores not killed by pasteurizing	Anthrax in man
Actinomycosis (lumpy jaw, etc.)	Pasteurize; discard in case of open lesions or udder infections	No record of transmission to man
Trembles (milk sickness)	Do not use	Vomiting, paralysis, death
Infectious abortion	Pasteurize or discard	May be injurious to man
Tuberculosis	Pasteurize	Children especially susceptible
Human Diseases:		
Typhoid	Pasteurize	
Paratyphoid	Pasteurize	
Septic sore throat	Pasteurize	
Tuberculosis	Pasteurize	
Diphtheria	Pasteurize	
Scarlet fever	Pasteurize	
Diarrhœa and dysentery (Probably carried by milk)	Pasteurize	
Whooping-cough	Pasteurize	
Measles	Pasteurize	

bacteria find their way into the human body, lodging in the throat (diphtheria), causing digestive disturbances in the alimentary canal (dysentery) or passing via the intestine to other parts of the body (tuberculosis to the lungs or lymph-glands, or typhoid into the blood). These pathogenic bacteria may be merely carried by the milk (*e.g.*, sore throat organisms left in the milk by the careless handling of a dairyman or waitress). Or if the temperature of the milk is favorable, such undesirable bacteria may actually grow and multiply in the milk, thereby increasing the probabilities of disease transfer.

That diseases are carried by milk has been proven beyond a doubt. Peculiar and easily recognized forms have been demonstrated by the microscope, *e.g.*, tuberculosis. Single cases and epidemics have been traced to milk supplies in ways that preclude their explanation as mere coincidences.

Not only are there a large number of diseases transmitted through milk, but a single supply may be responsible for many cases of disease. One diseased cow or one disease-bearing worker in a dairy may infect a large number of people—through a single lot of milk, or through successive lots of milk. Dozens or even hundreds of cases may be thus traced to a single cow or a single cook or dairyman. More often the people originally succumbing to the infection infect others (usually members of the same household) and the numbers increase rapidly, mainly through such secondary cases. Rosenau lists over 4000 cases of milk-borne diseases for Boston during 1907–11.[2]

1907—Diphtheria		72	cases
1907—Scarlet fever		717	cases
1908—Typhoid fever	about	400	cases
1910—Scarlet fever	over	842	cases
1911—Septic sore throat	over	2065	cases

An epidemic in New York City including over 400 cases was traced to a dairyman who had had typhoid 47 years previously; one in Washington was traced to a worker who had had typhoid over 40 years previously.

[2] The present milk conditions (pasteurization, refrigeration, etc.) do not provide such startling figures at present, fortunately.

Tuberculosis.—Cases of tuberculosis, which often develop very slowly, cannot be rated as epidemics, though probably similar wholesale inoculations of patrons occur. No figures can be given for the *human* type of tuberculosis transmitted by milk handlers who have the disease. We can indirectly, however, get minimum figures for *bovine* tuberculosis, basing them solely on the autopsies and examinations of patients showing the bovine type of infection. The examination of milk for tuberculosis organisms (Fig. 94) will also give an idea of the danger of contracting tuberculosis. In each of several large cities (New York, Chicago, Rochester, etc.) several dozen or hundred milk samples were examined recently and tuberculosis organisms occurred in from 2 to 16 per cent. of the samples.

Children are *more* susceptible than adults to bovine tuberculosis as indicated by the following statements made by various investigators:

1. At least 7 per cent. of the infants under five die of tuberculosis contracted from milk;

2. About 30 per cent. of the cases of tuberculosis of children under five are due to the bovine type;

3. About 30 per cent. of the tubercular glands (*e.g.*, neck) in children under sixteen are due to bovine bacilli; some investigators make it 90 per cent.;

4. About 17 per cent. of breast-fed children have tuberculosis; 35 to 40 per cent. of those fed on cow's milk have tuberculosis.

The large number of bacteria found in milk is explained in part by the initial sources, which are numerous and varied. The bacteria come mainly from the mouths, hands,[3] or clothing of the milker; from the manure,[4] the saliva, or diseased organs (udder (Fig. 20), adjacent lymph-glands) of the cow, or from small animals, such as rats or flies,[5] which carry dangerous bacteria on their

[3] From the unwashed hand of one dairy worker 45,000,000 bacteria were obtained; washing reduces the number in proportion to its thoroughness.

[4] A strong argument for strict stable cleanliness is found in the evidence that more tuberculosis organisms enter milk with the manure than through a diseased udder.

[5] Over a million bacteria have been obtained from the body of a single fly.

bodies (*e.g.*, typhoid from privy vault visited by flies). Besides the list already given there are many other possible sources: the utensils, water used for washing the utensils, bacteria (from soil, manure, etc.) temporarily suspended in the air (Fig. 21). These sources do not necessarily include bacteria pathogenic to man, but

FIG. 20.—Note the spongy character of the udder. This makes it practically impossible to rid the udder of invading bacteria which gain a foothold there.

they may, nevertheless, bring about undesirable quality changes already described as occurring in milk.

Temperature.—Not only is there opportunity for a wide range of foreign organisms, but these bacteria too often have every opportunity for rapid multiplication. On milking, the temperature of the milk is about that of the human body, and in large milk cans

(unless cooled quickly by ice) this temperature, so favorable to organisms pathogenic to man, may be rétained for several hours. How important temperature is in controlling the quality of milk is shown by the figures for one single sample of milk, which was divided into several different portions and kept at the respective temperatures indicated (p. 70). And such favorable temperatures are often found later in the history of the milk; *e.g.*, milk cans waiting in hot railway platforms, bottles left by the milkmen

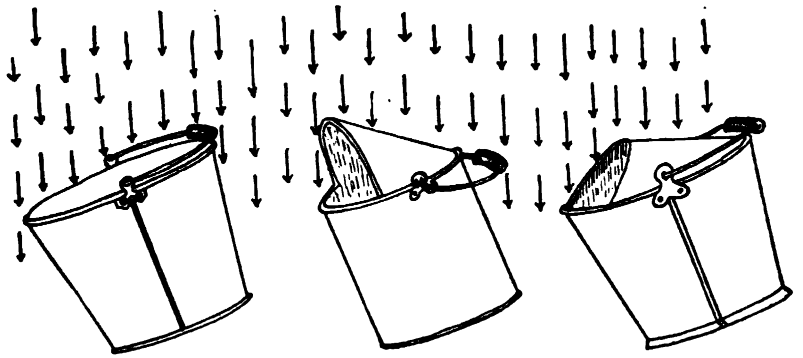

FIG. 21.—Types of milk pails to illustrate that relatively few bacteria fall into pails of approved types.

on sunny window sills for late-rising patrons, and milk kept in hot kitchens for several hours before using.

Add to these conditions the long time that must elapse before milk can reach its final destination. A short time ago New York City received milk from eight States and Canada. Milk delivered any given morning at a New York City house was often three days old; add to that one to two days for the time period in the house, and it will be seen that consumers are often using milk five or six days old. Taking also into consideration the rate at which bacteria may multiply one wonders that sweet, good-tasting milk ever reaches a city dweller.

The combined effect of time and temperature on bacterial multiplication is illustrated below. Fresh milk (initial count 3000 organisms per c.c.) was divided into four lots which were kept for ninety-six hours at different temperatures.

Temperature	Count per cubic centimetre	
	24 hours later	96 hours later
0° C. (32° F.)	2,400	1,850.
4° C. (39° F.)	2,500	218,000.
6° C. (42° F.)	2,600	500,000.
10° C. (50° F.)	3,100	300,000,000.
20° C. (68° F.)	500,000,000	Too numerous to count.

When we reflect that the shelves of the ordinary home refrigerator are often 10° C. (50° F.) we can see that the best place for milk is in the ice chamber itself. The low counts which were obtained at low temperatures during the first twenty-four hours are explained by bactericidal (G) substances in the milk; at high temperatures the resistant bacteria multiply too rapidly for this bactericidal effect to be noticed. This effect disappears in time, but a temperature near freezing keeps the bacterial count at that low level. At the slightly higher temperature of the ice chamber the increase is not alarming. Milk should be rapidly cooled after milking and should not be allowed to exceed 10° C. (50° F.) in transit or storage.

Milk Standards.—Considering all these opportunities for contamination and pollution, one wonders that we ever secure clean and safe milk. To aid in doing this certain standard requirements are usually made. These, of course, are *minimum* requirements regarding milk quality, and so eliminate only the poorest or most inferior milk. In some cities these standards are slowly raised, thus gradually insuring a better quality of milk, without too great injustice to the smaller milk producers.

Types of Standards.—The standards by which milk can be measured are (1) physical and chemical, *e.g.*, temperature (low enough to limit bacterial growth), and butter fat (which should be at least 3¼ per cent. of the total weight); (2) bacteriological, limiting the total number of bacteria, and to some extent, the kind (*e.g.*, intestinal, pathogenic); and (3) sanitary standards, relating to the conditions under which milk is produced (clean utensils, stables, etc.).

Milk adulteration is so much more a matter of lowering the quality (cream removal, addition of water) than the addition of deleterious substances that it will be treated under adulteration in

the chapter on foods (p. 34). It is sufficient to state here that the old tales of chalk in milk are usually unfounded; calves' brains bring too good a price to use them as an adulterant, and as Harrington points out, the supply is too limited for the claim to be worth serious consideration. Gelatin has been detected in adulterated cream. Chemicals as preservatives are, of course, illegal in any self-respecting community.

Methods of Testing Physical and Chemical Character.—There are several different types of apparatus for measuring the physical and chemical qualities of milk. A thermometer[6] is, of course, used in determining the temperature of milk.

The total solids are determined in various ways, but the methods are all based on one of two things: (1) evaporating the water in a given quantity of milk and weighing the balance left after the sample has been completely evaporated; and (2) determining the specific gravity (never below 1.027 in normal milk) and correcting it for temperature and fat content. For the latter method such correction is necessary, since fat is lighter than the other milk solids, and its removal may be hidden by adding sugar to give the usual total solids; such adulteration would enable a dairyman to sell the cream, and by properly adulterating the partly skimmed milk, pass it off as whole milk. The effect of temperature on specific gravity is also important; normal milk with a specific gravity of 1.027 might be rated higher or lower, 1.026 at 10° C. (50° F.), or at 1.028 at 20° C. (68° F.), thus giving incorrect impressions as to its possible adulteration. (Printed tables giving such equivalents are used for this determination.) The solids are, as earlier stated, mainly sugar, proteins, and fats. The first two vary little in normal milk, and if tests for either of these are made at all, it is usually for sugar, and then mainly to show whether additional sugar has been added to cover "watering" or cream removal. The solids to which most attention is paid are the fats.

Fat Tests.—These fat tests vary greatly in details and in the types of apparatus used, some of the methods and apparatus being very complicated. They may be roughly described as of two main types. In the first type the fat is completely liquefied and sepa-

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[6] The thermometer should be the ordinary milk or chemical thermometer, with the registering scale on or in the mercury tube. Those with wooden backs are usually not accurate, and are not easily cleaned.

rated from the balance of the milk. This is done by adding hot water and acid and by centrifuging (G). This is usually done in a glass vessel holding a definite amount of milk and having a carefully graduated neck (Fig. 22). The depth of clear liquid fat finally collecting in this neck is measured and translated into fat percentage by a special scale on the neck of the flask. In the second method of fat determination a given weight of milk is thoroughly

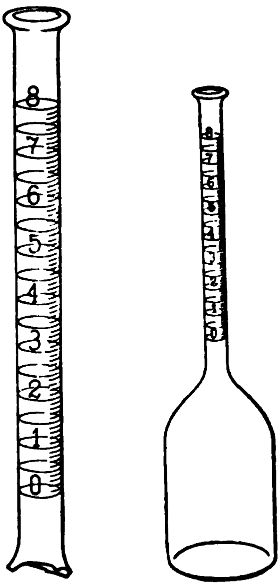

FIG. 22.—Babcock tester, with detail of neck on left.

mixed or washed in ether. This fat-absorbing ether is then taken off into a separate flask; the ether is allowed to evaporate, and the fat contained in the flask, when compared with the weight of the whole sample, shows the per cent. of fat.

Bacterial Content of Milk.—The bacteriological content of milk is measured in several ways. These methods may be divided into three main ones: (1) the microscopic, in which a sample of milk is placed under the microscope and examined for the kind or number of bacteria present; (2) the "plate" method (G), in which

a given amount of milk is mixed with gelatin or agar (G) and allowed to stand long enough for the bacteria present in the milk to grow into visible colonies; and (3) the inoculation (G) method, in which a small amount of milk is inoculated into an animal (*e.g.*, guinea-pig), and the subsequent fate of the animal or an examination of its blood indicates whether or not pathogenic bacteria were present in the milk sample used. These three methods are described somewhat more in detail below.

Microscopic Examination.—The microscopic method is used for two purposes: (1) to determine the presence of disease and certain disease-producing organisms; and (2) to indicate the whole number of bacteria present in the milk. In the first the examination is limited mainly to a search for white corpuscles and for two types of bacteria—streptococci (G) and tuberculosis. Some white corpuscles may always be expected in unstrained milk, but a large number indicates disease in the udder or adjacent lymph-nodes. The diseases causing such an overproduction of white corpuscles (G) are sometimes communicable to man (*e.g.*, septic sore throat and tuberculosis). Even if the diseases are not communicable ones, we would not knowingly choose such milk, and milk containing a suspiciously large number of white corpuscles should not be supplied to unsuspecting consumers. Some authorities state that the number in normal milk may even reach 1,000,000 per c.c.; and while all agree that they are greatly increased in diseased conditions of the udder and adjacent glands, few agree upon the upper limit to be allowed with safety. In most suspicious cases the milk often shows an undue number of bacteria also. Streptococci from the human mouth or from septic lesions (G) (sore throat, scarlet fever throats, abscesses), or from the cow (saliva, diseased udder) are usually in rather long chains, often twelve to forty in a chain, and sometimes in much longer chains. The streptococci and other coccus organisms from other or non-animal sources are rarely in such long chains; when a sample of milk contains long chains of coccus organisms it should be looked upon with suspicion. Human, bovine, and equine fecal streptococci are often of the long-chained type; while they are not generally considered pathogenic (G), they may be; besides, a fecal origin is not a pleasing explanation of their presence, and would not be tolerated knowingly by any consumer.

Tuberculosis organisms may be demonstrated in milk. They probably do not multiply rapidly in milk, and the small amount of milk that can be examined on a microscope slide might not contain any of the organisms. It is customary, therefore, to centrifuge (G) a larger sample of milk, and examine the sediment thus collected for tuberculosis organisms. They may be demonstrated by special staining (G) methods, and dangerous milk supplies (whether due to tubercular cows or to tubercular milkers) may be thus eliminated.

The preceding methods of examining milk are helpful in conditions where disease organisms are actually present. As we have already seen, milk may, however, be quite changed by other bacteria, and made wholly unfit for use (sour milk, food poisoning). The number of bacteria present gives some indication of how far these changes may have progressed. There are two common ways of determining the number of bacteria in milk: the microscopic and the plating method; the microscope method is also called the "direct count" method to distinguish it from the plating or "plate count" method (G); the bacteria are counted at once (directly) without an intervening growing period as in the plate count method. A direct count is made by placing a small sample of the milk upon a glass slide, staining it and counting through the microscope the bacteria seen in a large number of places (fields) on that slide. If the bacteria average per field is low, the milk can be classed as good milk; if the average is higher it is of fair or poor quality; the actual numbers[7] vary with the microscope used (Fig. 23).

The "plate" method (G) is the oldest and is still the one most generally used. It can readily be seen that there are certain disadvantages in each method and that the bacterial counts could not agree. It is only necessary to find the equivalent for each in terms of the other, for each has certain advantages and disadvantages not possessed by the other method. In the plate method all the bacteria present do not make visible colonies in the time period (2-3 days) elapsing before the plate is counted. Some of the bacteria, lacking their preferred or required foods, or not finding their

[7] The actual number of bacteria per c.c. can be estimated by determining the average number per field, and mathematically computing the actual size of the field and the number of such fields in the space covered by the milk as spread on the slide, and then correcting that total for the amount (part of a c.c.) used in making the slide. If a pair, a chain, or a mass is counted as a single organism, direct counts may parallel plate counts; if each organism in such groups is counted, the direct count is usually two to ten times the plate count. Each laboratory must determine its own ratio, as the technique employed will vary somewhat.

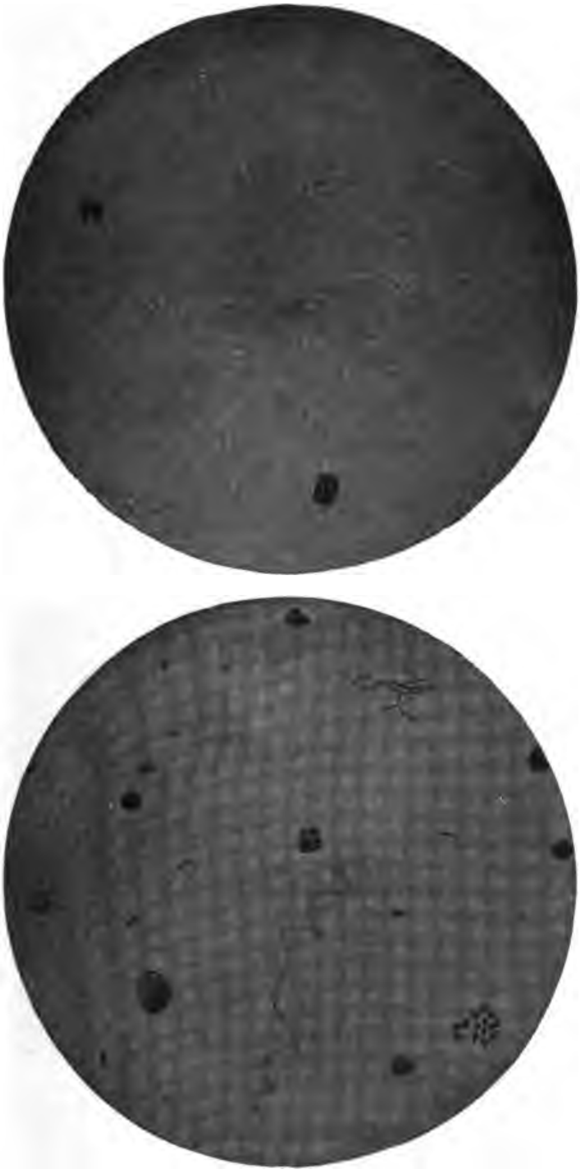

FIG. 23.—Two microscopic pictures, showing good and poor milk, direct count method (p. 74).

optimum conditions of oxygen and temperature, do not grow at all. The plate method, too, gives no indication of the dead bacteria in the milk. In the direct count method dead bacteria may stain and add greatly to the bacterial count; groups or clumps, if counted as individuals, increase the direct count. This is not necessarily a disadvantage, as we are, of course, interested in *all* the bacteria that have affected or are affecting the milk. The plate method demands more expensive material (agar, pipettes and glassware) and more labor (sterilizing); it also takes more time, and three to four days must be allowed for making the milk plates, incubating them, counting and recording the results. In that interval the milk has, of course, been consumed. The direct count demands fewer workers, but these must all be of higher calibre, *e.g.*, skill in microscopic and staining technique is necessary. The small sample often is less representative, some claim. The count can be quickly made, and suspicious or poor milk held back from the consumer. It also gives opportunity for making a strepto-cocci and a white corpuscle count, showing more clearly the possibility of disease transfer.

Accepted Bacterial Standards.—The counts allowed on agar plates have been unnecessarily high, in some of our cities as high as 500,000 organisms per c.c. It is gradually being lowered, and while 30,000 is considered a fair standard, there is no good reason why properly cooled milk should exceed 6000 per c.c. in winter or 12,000 in summer.

Sanitary Standards.—Sanitary standards are—strange to say—the most recent. They are based on the observances demanded by common decency and the ordinary standards of cleanliness. They are the only ones easily understandable by all producers (farmers and dairymen), and they have been emphasized mainly with the idea of securing the full coöperation of the producers. It is astonishing to know how few of the house standards "carry over" to the barn. In the house no one would put fresh milk into a dirty pan, drink milk into which a mischief-making person threw even a tiny particle of manure, or set a pan of milk where it would catch house dust (sweepings). Yet it has long been quite customary to milk into dirty pails; and most farmers feel quite abused if it is even suggested that strainers or straining cloths should not be used. "How else is one to take out the barn dirt (cobwebs, dust) and manure?" they ask, with the air of having settled the whole question. That dirt should be kept out in the first place, does not occur to them.

Sanitary standards attempt to cover more than mere foreign matter. The health of the cows is also important, and so besides sanitary rulings covering the stable floor, dust-making processes

during milking, removal of excreta, and cleanliness of the animals, the standards usually consider such of the surroundings as affect the cow's health. In such standards we find included not only tuberculosis, foot and mouth disease, and udder infections, but minimum ventilation and light requirements. The following score cards indicate the sanitary conditions usually demanded (Figs. 24 and 25).

But even in the most sanitary of surroundings careless milkers or other workers may produce a poor and even filthy milk. Some investigators feel that many of the sanitary requirements are not essential to clean milk. While cement floors, extra window area, etc., may affect the milk supply, they evidently do so to a less degree than the relative size of the milk pail top (Fig. 21), soiled hands of the milker, and similar details that can be changed at a merely nominal cost. Milking machines are variously regarded by dairymen. They are difficult to keep clean; if kept clean, however, a low-count milk is assured without so much attention to the body of the cow, room conditions, etc. A moist sheet with an opening to expose the udder can be used at milking time; it takes less time than washing the body and affects the cow's skin less than repeated washings (eczema-like eruptions).

The North System.—By insisting upon a few essentials: "dry milking,"[8] a small-mouthed pail, prompt cooling and prompt delivery of the milk, and having the returned milk cans all sterilized *at the dairy* ready for the next consignment of milk, a clean and low-count milk can be produced even in poor barns. These are summed up as the three great considerations: method of milking, cooling, and sterilizing of utensils (Fig. 26). This does not mean that the health of the cow is not considered; in this system a premium (one-half cent a quart) is paid for tuberculin-tested cows. This method, it is claimed, has secured a good quality of milk, often averaging below the 10,000 to 25,000 per c.c. limits set by the receiving stations.

As North says, milk may be safe because it has been boiled, but still indecent because it is filthy. As long as consumers do not in-

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[8] In "wet milking" the hands are moistened, usually with the fore milk, as some milkers feel it is necessary to have the hands wet to give the necessary ease in milking. Saliva is even more undesirable as a moistener, and "dry milking" should be insisted upon.

(Back of Card)

Equipment	Score: Perfect	Score: Allowed
COWS		
Health	6	......
Apparently in good health.....1		
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed.............5		
(If tested within a year and reacting animals are found and removed, 3.)		
Food (clean and wholesome)	1	......
Water (clean and fresh)	1	......
STABLES		
Location of stable	2	......
Well drained.............1		
Free from contaminating surroundings.............1		
Construction of stable	4	......
Tight, sound floor and proper gutter.............2		
Smooth, tight walls and ceilings 1		
Proper stall, tie, and manger...1		
Provision for light: Four sq. ft. of glass per cow	4	......
(Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)		
Bedding	1	......
Ventilation	7	......
Provision for fresh air, controllable flue system.............3		
(Windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 ft.............3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature.............1		
UTENSILS		
Construction and condition of utensils	1	......
Water for cleaning	1	......
(Clean, convenient, and abundant.)		
Small-top milking pail	5	......
Milk cooler	1	......
Clean milking suits	1	......
MILK ROOM OR MILK HOUSE		
Location: Free from contaminating surroundings	1	......
Construction of milk room	2	......
Floor, walls, and ceilings...1		
Light, ventilation, screens...1		
Separate rooms for washing utensils and handling milk	1	......
Facilities for steam	1	......
(Hot water, 0.5.)		
Total	40	......

Methods	Score: Perfect	Score: Allowed
COWS		
Clean	8	......
(Free from visible dirt, 6.)		
STABLES		
Cleanliness of stables	6	......
Floor.............2		
Walls.............1		
Ceilings and ledges.............1		
Mangers and partitions.............1		
Windows.............1		
Stable air at milking time	5	......
Freedom from dust.............3		
Freedom from odors.............2		
Cleanliness of bedding	1	......
Barnyard	2	......
Clean.............1		
Well drained.............1		
Removal of manure daily to 50 feet from stable	2	......
MILK ROOM OR MILK HOUSE		
Cleanliness of milk room	3	......
UTENSILS AND MILKING		
Care and cleanliness of utensils	8	......
Thoroughly washed.............2		
Sterilized in steam for 15 minutes.............3		
(Placed over steam jet, or scalded with boiling water, 2.)		
Protected from contamination..3		
Cleanliness of milking	9	......
Clean, dry hands.............3		
Udders washed and wiped....6		
(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		
HANDLING THE MILK		
Cleanliness of attendants in milk room	2	......
Milk removed immediately from stable without pouring from pail	2	......
Cooled immediately after milking each cow	2	......
Cooled below 50° F.	5	......
(51° to 55°, 4; 56° to 60°, 2.)		
Stored below 50° F.	3	......
(51° to 55°, 2; 56° to 60°, 1.)		
Transportation below 50° F.	2	......
(51° to 55°, 1.5; 56° to 60°, 1.)		
(If delivered twice a day, allow perfect score for storage and transportation.)		
Total	60	......

Equipment.................... +Methods.................... =....................Final Score.

Fig. 24.—Back of score card recommended by the Dairy Division of the Bureau of Animal Industry, U. S. Department of Agriculture.

Date........................ **Dairy of**..........................

		Perfect	Score
I. Health of the herd and its protection	Health and comfort of the cows and their isolation when sick or at calving time............	45	
	Location, lighting and ventilation of the stable.	35	
	Food and water...........................	20	
	Total..............................	100	
II. Cleanliness of the cows and their surroundings	Cows..................................	30	
	Stable................................	20	
	Barnyard and pasture......................	20	
	Stable air (freedom from dust and odors)......	30	
	Total..............................	100	
III. Construction and care of the utensils	Construction of utensils and their cleaning and sterilizing..............................	40	
	Water supply for cleaning and location and protection of its source......................	25	
	Care of utensils after cleaning................	20	
	Use of small-top milking pail................	15	
	Total..............................	100	
IV. Health of employees and manner of milking	Health of employees......................	45	
	Clean over-all milking suits and milking with clean, dry hands.........................	30	
	Quiet milking, attention to cleanliness of the udder and discarding fore-milk............	25	
	Total..............................	100	
V. Handling the milk	Prompt and efficient cooling................	35	
	Handling milk in a sanitary room and holding it at a low temperature....................	35	
	Protection during transportation to market....	30	
	Total..............................	100	
	TOTAL OF ALL SCORES.................	500	

If the total of all scores is	And each division is	The sanitary conditions are
480 or above................	90 or above....................	EXCELLENT
450 or above................	80 or above....................	GOOD
400 or above................	60 or above....................	MEDIUM
Below 400..................	Or any division is below 60......	POOR

The sanitary conditions are......................... Scored by...................

FIG. 25.—Simpler score card recommended by the College of Agriculture, Cornell Universit

sist upon having what Conn calls "clean milk, not cleaned milk," these conditions will continue. They are due partly to ignorance,

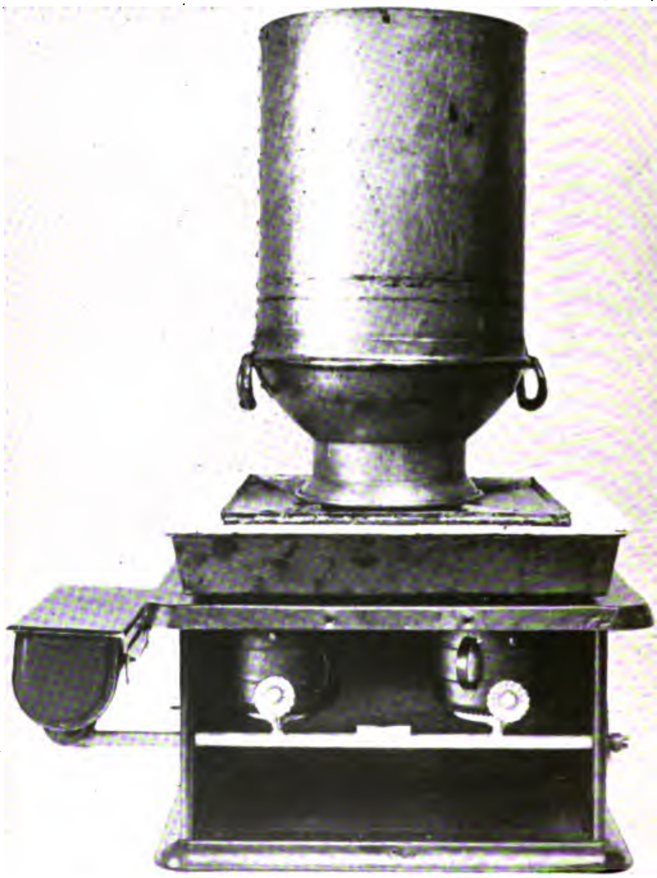

FIG. 26.—A simple way of sterilizing a milk can. A large flat pan filled with water is placed on the stove; as this boils steam (under slight pressure) fills the inverted can.

but more often to carelessness; and the opaque liquid character of milk helps conceal its unsavory past.

Pasteurization.—Therefore, because we cannot feel certain that our present laws secure to us safe milk, pasteurization is growing in

popularity. All but three of our fifty largest cities insist upon pasteurization.

Pasteurization [9] is a process which involves the heating of milk to a sufficiently high temperature to kill the pathogenic organisms most often found in milk. In pasteurizing milk on a commercial scale the milk may run through heated pipes, or be held in large cans, special tanks (Fig. 27), or in the final bottles. Some claim sufficiently high temperature for killing pathogenic organisms and

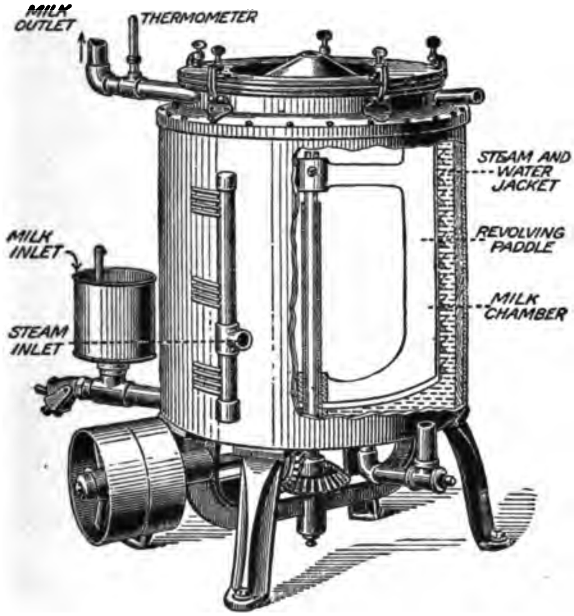

FIG. 27.—One of the simplest of the commercial pasteurisers. A revolving paddle insures an even temperature.

neutralizing some of the bacterial products [10] may be obtained by raising the milk to 80° C. (176° F.) for one minute, or simply raising it to 81° C. (178° F.)—the "flash" methods. Most workers find the desired results only certainly and uniformly

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[9] It is so named because it is practically the method adopted by Pasteur in wine making to keep down the growth of certain undesirable organisms.

[10] Some bacterial ptomaines and toxins (G) survive even boiling. Pasteurization cannot, therefore, take the place of cleanliness during milking, or low temperatures after milking, etc.

obtained by raising the temperature to 60° C. (140° F.) for twenty to thirty minutes. Klein advocates 62.8° C. (145° F.) for at least thirty minutes, and it would seem wise to adopt his higher and surer temperature and time standards.

City dwellers are usually protected by local regulations demanding pasteurization. In less densely populated districts milk is often sold in a raw state. If there are no legal standards requiring pasteurization, there are usually none regarding bacterial content. In all such cases it may be necessary to pasteurize the milk at home. The U. S. Department of Agriculture, the New York City Board of Health, and other reliable authorities have issued simple directions for home pasteurization (see Appendix).

Objections Made Against Pasteurizing Milk.—Despite a general opinion to the contrary, pasteurized milk will sour quite normally, and it is used by several large firms for making cheese and butter. If milk contains an unusual number of protein-breaking bacteria which are spore (G) producers, pasteurization may leave an unusual proportion of these behind, and as they develop the milk may become putrid, slimy, etc., instead of souring in the usual way. It is probable that only the poorest, or least clean, milk is so affected by pasteurization.

Pasteurized milk, it was once feared, might be passed off as high-grade raw milk, without detection, as it gives a low plate count, etc. But there are two checks on such dishonest practices: (1) characteristic enzymes (G) may be killed if pasteurized at high temperatures, at 79° to 80° C. (174° to 176° F.); another check is found in the fact that the white corpuscles (G) are changed, (heated white corpuscles stain less readily and are smaller in size).

The other chief objection to pasteurization is that it changes the nutritive quality of the milk. Malnutrition, scurvy, and general digestive difficulties have been attributed to such heated milks; and it is also claimed that such heating renders essential food elements insoluble, kills necessary enzymes,[11] and destroys the vitamines (see p. 27). The following thermometer (Fig. 28) shows the relative temperatures at which these changes really occur—decidedly above the recommended and customary pasteurizing temperatures.

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[11] There may be some loss in ordinary milk enzymes (diastase, galactase, oxydase, etc.). It is doubtful if these are really serious, though most experts think it wiser to retain them.

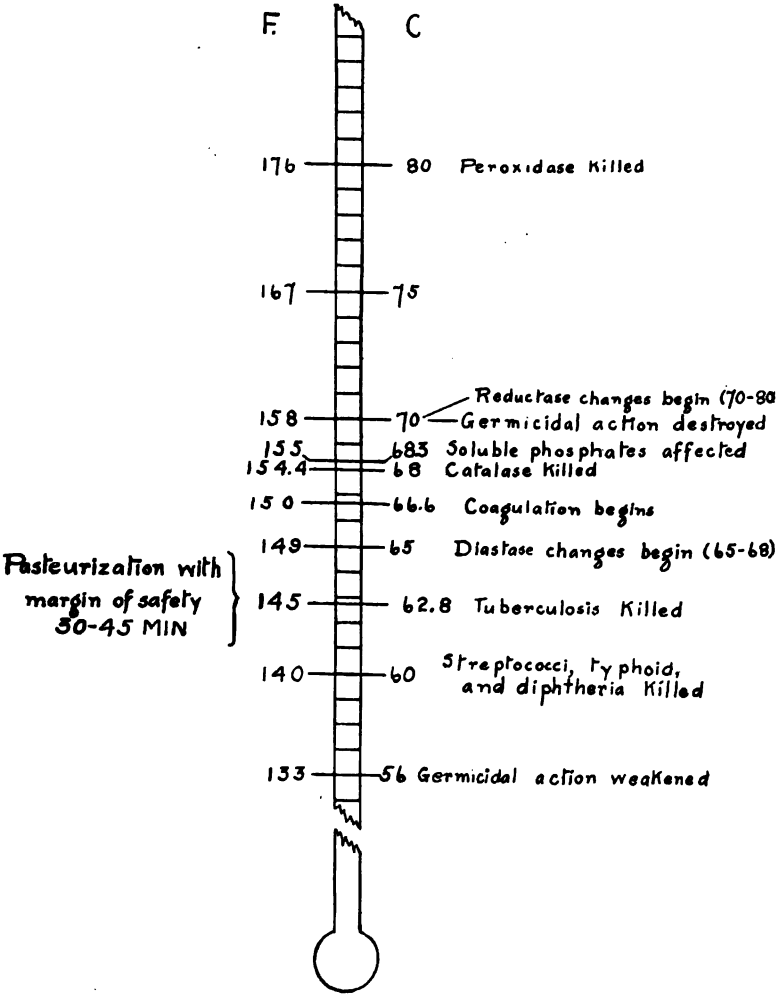

FIG. 28.—This thermometer shows the relation of various heat changes in milk to the pasteurizing temperature. Both Centigrade and Fahrenheit temperatures are given (see Appendix).

Since milk is pasteurized to render it safe, great care must be taken to see that the treatment following pasteurization does not annul the benefits of pasteurization. The milk should be cooled

quickly and kept below 10° C. (50° F.) until used or delivered. Careless handling during bottling should be guarded against; this presupposes using sterilized bottles and capping or sealing by machinery.

Part of the prejudice against pasteurization is due to the fact that it was originally advocated to delay the spoilage of milk and that it may mask careless or filthy methods. That is undoubtedly true, but as long as the community thinks it cannot afford to pay the higher price of producing a sanitary though unheated milk, and as long as inspection of the widely distributed farms that supply our milk is as inadequate as it is, it is the only safe method.

Pasteurized Milk for Babies.—Physicians—even those with bacteriological training—often express violent prejudices against pasteurized milk. This, however, is not supported by the results obtained in infant welfare work (see p. 289).

Still more convincing is the following report by Park and Williams, based on a series of observations on nearly one hundred children.

Type of milk	No. infants	No. well all summer	No. ill (diarrhœa)	Average weekly gain	Deaths
Pasteurized milk......	41	31 (75 per cent.)	10 (24 per cent.)	4 oz.	1
Raw milk...	51	17 (33 per cent.)	33 [12] (64 per cent.)	3.5 oz.	2 [12]

Children over three and adults can use raw milk with considerably less danger of diarrhœa and dysentery. Adults are also less susceptible to bovine tuberculosis. These facts do not militate against pasteurization, because septic sore throat, diphtheria, scarlet fever, and typhoid, so commonly spread by milk, attack all ages.

Milk Quality.—In other foods consumers are willing to pay for higher quality. In canned goods, package foods, and unlabelled foods—meats, eggs, vegetables, dried and fresh fruits—we unhesitatingly pay the excess demanded for high-grade goods. MacNutt rightly asks why we accept four or five grades for eggs and are generally contented with but one grade of milk—certified milk excepted for a small percentage of the consumers. It must be

[12] Thirteen of the children were transferred to pasteurized milk because of serious illness. The figures would doubtless be more markedly in favor of pasteurized milk otherwise.

admitted, however, that to most people "milk is milk," and quality —except the "cream line"—is not considered at all.

Market Standards.—Definite standards have been demanded by alert committees. The reports of the Commission on Milk Standards have been important in shaping the standards of many localities, since they have been indorsed by the American Public Health Association and the American Medical Association. They are given (in a somewhat condensed form) below:

Grade A:		
	Raw	Cows free from disease: Tuberculin-tested (G); Examined by veterinarian. Workers (with milk and cows) free from disease determined by medical inspection. Sanitary conditions good. Bacterial count not above 10,000 per c.c. at time of delivery.
	Pasteurized	Cows free from disease—examined by veterinarian. Sanitary conditions good. Bacterial count not above 200,000 at any time before delivery. Pasteurized (official supervision) and count not above 10,000 at delivery.
Grade B:		
	Pasteurized only	Cows free from disease—examined by veterinarian. Sanitary conditions good. Bacterial count not above 1,000,000 per c.c. before pasteurization; 50,000 at time of delivery.
Grade C:		
	Pasteurized only	Cows free from disease—physical examination. Includes all milk with bacterial count exceeding 1,000,000 per c.c. Bacterial count less than 50,000 per c.c. when delivered to consumer. Restricted to cooking and manufacturing purposes.
	Cream	Classified in same grades as milk excepting bacterial standards, which vary in proportion to fat; *e.g.*, in 18 per cent. cream it must not exceed 5 times that for the same grade of milk.

There are several favorite terms for milk used by various dairy companies: select, selected, guaranteed, inspected, certified, baby-milk, etc. Unless the firm using any one of these terms can give a definite meaning for the term used, and support it by specific reference to legal standards demanded by the State, city, or local health boards, the term may be absolutely meaningless. For example, *inspected* would not necessarily mean inspected by a veteri-

narian nor for tuberculosis, but merely that a member of the dairy firm inspects the farm (most casually even) once a year or so. Consumers should not pay fancy prices for milk without full return in food content, and in freedom from bacterial infection and decomposition.

The only special term of fairly uniform meaning throughout the United States is "certified" milk. The word "certified" was apparently coined by Doctor Coit, of Newark, N. J., in an endeavor to secure a safe, high-grade milk for babies. It has been adopted by the American Association of Medical Milk Commissions, and is legally protected in a number of States. In such States it means milk produced under good sanitary conditions by a producer who has entered into an agreement with a medical milk commission to fulfill its requirements; in return the producer is allowed to use the term "certified." The requirements are most detailed; food, sanitary conditions, the milkers, age of milk when delivered, etc.

Certified milk...	Highest quality of raw milk (fat, protein). From tuberculin-tested cows. Bacteria limited to 10,000 per c.c. when delivered (bacterial examination made weekly). Sanitary conditions.[13]

How far we are as a country from a thoroughly good milk supply may be seen from the fact that MacNutt estimates the total production of certified milk to be but 25,000 gallons daily for the whole United States—less than 1 per cent. of the whole milk supply. An incentive to the production of clean milk which consumers are slow to award is an increase in price sufficient to repay the producer for the increased outlay of time and money. Put thus plainly, it is difficult to see how one could hesitate. Pure, clean milk cannot be produced as cheaply as can dirty milk. As long as we continue to ignore differences in milk quality and refuse to pay a fair price for the time and labor necessary to produce clean milk, we will continue to have but one grade of milk, and that a poor one.

Milk is expensive to produce. In an eastern milk station the estimated cost of keeping one cow, including her share of the barn and other overhead charges (which any good business man would consider but fair), ranged from \$85 to \$165 per year. The pro-

[13] This is open to very loose interpretation, of course, and such laxity is but partly counteracted by the low limit for bacteria.

duction cost per quart ranges from 3.5 cents to 4.5 cents. In country towns in this same State milk retails for six cents a quart (March, 1918). The price paid at the collecting station is considerably lower. It can be readily seen that the farmer has but a small margin of profit; many farmers have found (on establishing competent book-keeping methods) that they have been selling milk at a decided loss. We must, therefore, expect to pay a high price [14] for milk. A fair price is bound to be a high price.

Publishing the test results (fat, bacteria, etc.) helps in an intelligent community or in the smaller towns where the consumer can connect such reports with the respective producers. In certain localities milk has a certain price as milk: but a substantial premium is paid for excess butter fat; low bacterial count (under 10,000 per c.c.), and for milk from tuberculin tested cattle.

The following milk bill issued at one of the North collecting stations shows a premium of $37 on $191—nearly 20 per cent.—enough to make any farmer "take notice." Note, however, that it raised the price but eight mills per quart. What consumer would not pay that extra eight-tenths of a cent cheerfully?

New York Dairy Demonstration Co., Homer, N. Y., to Mr. Blank, Dr.

1912.		
Dec. 1.	To 4500 quarts of milk at 4¼c	$191.25
	To premium butter fat 3.9 per cent. at 2c	9.00
	To [premium] tuberculin test at ⅜c	16.87
	To [low count premium] bacteria at ¼c	11.25
Total		$228.37

MILK PRODUCTS

Preparations Involving Loss of Water.—An earlier table (p. 63) has given the standard composition of milk products that are sold as evaporated milk, condensed milk, etc. These, including milk powders, by the various processes of profitable preparation—whole or partial evaporation of the contained water at high temperatures—are usually freed from bacteria. The water may be

[14] In milk, as in many other foods, the middleman seems to make an unfair share of the profit. In the case above mentioned, while milk was retailing in the farm neighborhood for six cents a quart, the same milk retailed in the nearby city for sixteen cents a quart. It seems clear that the farmer has too little part of this sixteen cent selling price for his labor and for the money invested.

evaporated by boiling, but more often is removed by spraying the milk in finely divided amounts into a heated chamber or tank. The addition of sugar to sweetened ("condensed") milk adds to its keeping quality. If too high temperatures are used, the sugar caramelizes, and various brownish colors result, depending upon the degree of change of sugar to caramel. Consumers receiving such overheated cans are often unduly distressed over "spoiled" milk. The hygienic problems connected with such milks are, therefore, mainly those of adulteration (sugar for bulk, etc.). It is not thought that the vitamines are greatly affected in such partly-evaporated milks. For baby-feeding, if these must be used, vitamines may be added as in pasteurized milk (see p. 27).

Soured Milk Drinks.—Among the soured milk products are several types known locally or commercially as Metchnikoff milk, fermillac, lacto-bacillas, matzoön, koumiss, and by many other names. These are milk, usually cow's milk in this country, in which special organisms [15] have developed, and formed a high percentage of acid, often 4 per cent. (Most bacteria normally souring milk cease their activity after the amount of acid reaches about 1 per cent.) The organisms causing the higher amount of acid are transferred from one lot of soured milk to another lot of sweet milk in various ways. A spoonful may be used as a starter; some firms sell tubes of liquid or tablets containing these bacteria; in some countries strings dipped in the sour milk are dried, and later used to inoculate the next lot of milk; "kefir grains" are tiny masses of these organisms (besides the bacteria distributed as usual through the milk, large numbers adhere in these so-called "grains" or "bee-bread"). In very warm countries where ice is practically unknown and milk changes would progress rapidly, large amounts of harmful protein-decomposition products may result. Since most of the bacteria causing such undesirable products do not grow rapidly in the presence of acid, soured milks are quite free from harmful accumulations.[16] In Arabia, Armenia, and other warm countries, sour milk is a favorite drink; and, in fact, in some localities sweet

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[15] These are usually bacteria; sometimes pure cultures are used, sometimes a mixture of two or even more organisms. In some, yeasts and even molds are present.

[16] While usually true, at least one epidemic has been traced to buttermilk.

milk is not used at all unless it is cooked. Such fermented milks are more easily digested than the curds of ordinary sour milk.

Recently, soured milks have been much advertised as having other valuable qualities: (1) that the acid contained (or else formed later in the intestine) is unfavorable to certain undesirable bacteria—disease organisms, such as typhoid and many forming poisonous proteins; and (2) because of the inhibiting action just described they improve the general health and so prolong life itself. Acting on this general theory, typhoid patients are often promptly put on a sour milk diet. Besides the known digestive advantages of such soured milk the contained organisms may displace and inhibit the typhoid bacteria.

A large number of people seem to be benefited by a milk diet, but it probably is not wholly due to the so-called Metchnikoff theory, and most people would do well to make no decided change in their diet without the advice of a physician.

Butter.—Butter, another milk product, interests us mainly from the point of adulteration (see p. 34). That is discussed in the chapter on foods. In the old way of butter making the bacteria present cause the souring of the milk before the cream is skimmed; in most creamery methods certain types of bacteria (starters) are put into the separated cream to bring about desired taste or flavor changes. Unusual or undesirable types cause bitter, rancid, fishy, or other tastes in butter. The ease with which butter absorbs odors may lead one to think a butter dangerous, when one is really smelling or tasting the wood of the butter tub or the turnips in the kitchen ice box. In certain French and Swiss localities pleasing butter flavors are assured by placing the butter near violets, tuberoses, and similar sweet-scented plants. Disease organisms present in the milk may be found in butter and cheese made from that milk. Well-known firms are, therefore advertising butter and cheese made from pasteurized milk. This proves the falsity of the popular belief that pasteurized [17] milk will not sour. With the use of butter and cheese starters, good butter and several types of cheese have been made from pasteurized milk by the Dairy Division of the Department of Agriculture.

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[17] Clean milk sours quite normally. Milk containing an unusual proportion of spore-forming, protein-breaking bacteria may not sour in the usual way; such milk is usually filthy milk.

While it is difficult to secure any figures showing that tuberculosis, typhoid or other diseases are caused by butter,[18] examination of butter has recently shown tuberculosis present in 2 to 5 per cent.—rarely in 10 per cent.— of the samples examined. A similar but harmless organism, presumably from water, is sometimes confused with tuberculosis organisms. The small amount of water in butter means a rather high salt percentage; this has a deterrent action on bacteria and increases its "keeping" quality. The various types of butter and cheese have little hygienic significance, their differences from that point being mainly a matter of difference in flavor and relative food value (skim milk, whole milk, etc.). For the methods of making butter and cheese, consult the references for this chapter.

Renovated Butter.—Renovated butter might be mentioned here, as our interest in that is not the same as in *sweet* or fresh butter or in the types of cheeses. Long-soured or old milk or rancid butter may be treated to remove objectionable accumulated substances: aerated to remove odors, treated with lime to counteract acid and redissolve the casein, washed to remove rancidity, and, finally, colored, rechurned, and *good,* pleasing butter secured. There is little indication that it is harmful to consumers. Renovated butter is not lacking in vitamines.

Cheese.—The only other milk product of hygienic importance is cheese. As indicated under adulteration, labels should state whether the cheeses are made from milk with cream additions, whole milk, or skim milk. Other additions should be indicated—such as bean meal, bread crumbs, potatoes, and lard. Such additions class the cheeses as "filled cheese." Lard is the only common addition in this country. The United States standard asks for 50 per cent. milk fat, but good grade American cheeses usually contain about 36 per cent. fat, 30 per cent. protein, 4 per cent. salt, and the balance of water.

Food poisoning is less often due to cheese than to milk itself. As in butter making, the early acid stages discourage the growth of most protein-breaking bacteria. The work of the Bureau

[18] It is usually impossible to trace the butter back to the contributing cow. The long latent or incubation period of tuberculosis, the varied sources of typhoid carriers (water, milk, unwashed vegetables), often make it almost impossible to trace the cause of such diseases.

of Animal Industry (p. 89) indicates that high-grade cheeses can be made from pasteurized milk. The danger of poisoning food is thereby lessened. Some thirty years ago over 300 cases of "ptomaine poisoning" in Michigan occurred in less than two years. The danger from cheese, nevertheless, is not great.

Cheese made from pasteurized milk will not convey the ordinary disease organisms. Fresh cheeses (cream cheese or cottage cheese) may hold typhoid from five to twelve days. Some cheeses take several months to ripen; a few as long as three or four years! These are quite unlikely to convey pathogenic organisms.

PROBLEMS

1. What legislation protects your milk supply?
2. What reasons have you for thinking this legislation is not enforced?
3. What changes do you think desirable for the consumer?
4. Is the price of milk in your community fair to the farmer? to the milk dealer? to the consumer? What can you do about it?
5. What special terms (inspected, certified, etc.) are used in your locality? Which have legal standing? definite meaning?
6. Write a farmer's bulletin presenting to him forcibly and clearly the hygienic phases of the milk problem from the consumer's point of view.
7. What are the things concerning milk you would change on the farm you know best?
8. How can a safe raw milk or a clean pasteurized milk be secured for all the babies in your community?
9. Has your community any standards for ice cream (addition of lard or gelatin, bacterial count, cleanliness of utensils)?
10. Write a clear statement of how each housekeeper should care for or treat the kind of milk available in your community. Include as many of the following points as the type of milk supply (raw or pasteurized. loose or bottled) makes necessary: temperature, washing and scalding of bottles, pails or pitchers, covering to keep out dust or flies, and home pasteurization.

See Reference List at end of Appendix.

CHAPTER V

WATER

THE important part water plays in our present methods of living is wholly unappreciated by most of us. As in the case of air, if we think of it at all, it is as a natural, limitless part of our environment about which we need "take no thought." It takes a frozen water main or a summer in an isolated camp, necessitating our personal services as "carriers of water" for house and personal uses, to jog us into a realization of its many uses, or to make us see that it is possible to decrease materially the large amounts we carelessly assume to be absolutely necessary.

Uses of Water.—Occasionally a ruminating mind wonders vaguely at the universal uses of water: its value as a liquid carrier of nutrients for both plants and animals; its universal solvent action, absorbing oxygen[1] from the air and making life in its depths possible, extracting needful substances from the soil, or making possible the cleansing of floors, dishes, and clothing; its historical and biological effects on the vast areas of land it has separated for centuries; or its continuous circulation between sky and earth, with the resultant climatic effects.

But its rôle in health and sanitation is rarely dwelt upon consciously; and when it is the subject of consideration our main interest is rather in the amounts consumed than in the amount essential to health from the physiological or the hygienic standpoint. Its uses in the body may, perhaps, be summarized here (1) to show that a certain amount is absolutely necessary and (2) to emphasize the fact that because of the intimate associations the quality of that supply is most important.

Water in Relation to the Human Body.—In the human body, water fills a most important office. At least 70 per cent. of the

[1] It is interesting to know that the "air" in water differs in its composition from that which ordinarily surrounds us; it contains 35 per cent. of oxygen instead of the usual 21 per cent. Every gas (and water absorbs to some degree every known gas) is absorbed separately and according to its respective "solubility."

body weight is water; water enters into the chemical composition of the cells; it keeps the cell surfaces moist, not only on exposed membranes, mouth, nasal cavity, etc., but even in the deeper tissues, for all living cells are in contact with a water-bearing medium (blood or lymph) making possible the characteristic pliability and elasticity of the muscles and tendons; it is a solvent for foods and gases—a most important function, as no substances, even gases, enter or leave the living cells except in solution; water also forms a medium (blood, lymph) for distributing body heat, and by its excretion in considerable amounts (lungs, kidneys, and skin) it helps to maintain normal body temperature.

Source of Body-water.—The oxidation of foods yields a part of the water needed by the body, *e.g.*, sugar utilized in the body forms water ($C_6H_{12}O_6 + O_{12} \rightarrow 6(CO_2) + 6(H_2O)$). A small amount enters the body in the semi-solid or even in the so-called solid foods (a little more than a pint or about half a litre). The balance must be taken as water, at least two quarts daily.

Different Classes of Water.—As stated before, this intimate and general use of water in the body indicates that the kind of water supplied is of great importance, especially with regard to its bacteriological content. Absolutely pure water, as Harrington points out, is never found in nature, and is never seen except in small amounts as a laboratory curiosity. All water holds minerals and gases in solution and usually small particles in suspension (*e.g.*, dust, bacteria). As we ordinarily use the term pure water, however, we mean free from harmful ingredients. By an engineer no water containing minerals affecting the machinery would be classed as pure; from a sanitary standpoint pollution due to animal or human wastes would render the water impure. Rosenau's classification of water as (1) good, (2) polluted, or (3) infected is both simple and practical. He says: "A good water may be defined as one of good sanitary quality, as determined by physical inspection, bacteriological and chemical analyses, a sanitary survey of the watershed, and, finally, by clinical experience. A polluted water is one containing organic waste of either animal or vegetable origin. A polluted water is a suspicious water. An infected water contains the specific micro-organisms of human diseases."

Most waters are polluted in the sense just defined. Surface waters could hardly escape such pollution. Such pollution is not

necessarily injurious, though it may—if very heavy—mean a high percentage of organic matter and so support the growth of undesirable bacteria, if such find their way into the water supply. Well and other ground waters usually contain much less organic matter, but many of the minerals they contain result from the decay or breaking down of plant and animal substances—sometimes termed the "mineralization of organic matter."

Other mineral substances affecting the potable quality of water are the wastes from mines and manufacturing establishments. These rarely affect the water supply except in closely populated districts, and there they are usually a part of the whole question of sewage disposal (see Chapter VII, p. 160).

Water-borne Diseases.—Disease organisms leave the body mainly in the sputum, nasal discharges, urine, and feces. Such human wastes infect water with the specific organisms of disease (*e.g.,* typhoid) and render it unsafe for human consumption. If the contents of sewers, drains, swimming-pools, and privies are allowed to enter the water supply, the whole question of sewage disposal becomes an important part of the water problem.

Such water-borne diseases may cause epidemics of typhoid, dysentery, and similar diseases; even when this is not so, such diseases often form an undue proportion of the yearly deaths, and the death rate is higher than that of similar neighborhoods differing only in having a safe water supply. For example, in 1905, Philadelphia with a population of 1,417,002 had 724 deaths from typhoid, while Camden, on the opposite side of the Delaware River, with a population of 87,000 had but 15 typhoid deaths. In other words, Philadelphia, taking its water from the Schuylkill River, with but sixteen times the population of Camden, had fifty times the typhoid death rate of Camden, whose water at that time came from deep-bored wells.

This effect upon the typhoid death rate is also shown by the following table, which gives the deaths per 100,000 for several cities in about the same latitude. Note particularly the differences between Jersey City and New York, cities like Camden and Philadelphia so close together that the difference in the water supply must be the main cause of the difference in the typhoid rate; considering the heavy daily migration across the separating rivers, one wonders how much greater the contrasts really are.

City (1896)	Source	Rate per 100,000 Deaths
Brooklyn	Wells and impounded[2] water	15
New York City	Impounded water	16
Detroit	Detroit River	20
Providence	Pawtuxet River	27
Philadelphia	Delaware and Schuylkill Rivers	34
Cleveland	Lake Erie	43
Chicago	Lake Michigan	46
Pittsburgh	Allegheny River	61[3]
Jersey City	Passaic and Pequannock Rivers	61.5

A large number of epidemics have been shown to be water-borne. Rosenau mentions five typhoid epidemics in the United States in which each outbreak was traced to a single individual. One was traced to a man who contracted typhoid while on a Christmas visit. The discharges were thrown out on the snowy hillside just above the town reservoir, and three weeks after the spring thaw began, the first cases occurred in the town below. They finally totalled one-sixth of the total population of the town. These five individuals are credited with 3929 cases of typhoid, including 361 deaths.

Relation of Water to General Health.—In various cities—though not all—the establishment of a better water supply has shown not only a decrease in water-borne diseases but also a decrease in other diseases, notably tuberculosis, pneumonia, and other respiratory diseases which are not commonly considered water-borne (see Chapter XIX).

This decrease ("the Mills-Reincke phenomenon") is partly explained by some as due to the purer water supplied; for the vital resistance (G) of the body may be lowered by drinking water charged with large numbers of bacteria even though they are not specifically pathogenic. Others feel this phenomenon is merely a coincidence; that any community spending large sums on improving its water supply is also sufficiently alert to the general hygienic problems to improve other conditions also, *e.g.*, housing and milk supply.

Ice in Relation to Disease.—Single cases of typhoid and a few

[2] Impounded is a term applied to water from rivers, watersheds, etc., held back by dams. Such water forms huge basins or open reservoirs.

[3] River water rates vary much more than other waters; in 1906 Pittsburgh's typhoid rate was 120!

small epidemics have been reported as traced to ice. This is not surprising when one recalls how ice is collected and treated. Natural ice is cut and harvested with little regard for ordinary sanitary observances, men and horses working on its surface for days at a time. In manufactured ice, if made in closed tanks, the water is first boiled or distilled to get rid of sediment and air. When the artificial ice is frozen in flat open pans (plate ice) part of the sediment settles; the rest of it and the air are extruded in the freezing process, and it is not necessary to boil the water first in order to get clear ice. Plate ice is, therefore, not safe unless a reliable water supply is used, or unless the manufacturers do take the extra trouble of boiling the water first.

During freezing and subsequent storage many bacteria are killed. For typhoid, which interests us most, though dysentery and other water organisms are also important, the following results are given by different workers.

The freezing process itself	50– 70 per cent. killed
Storage after freezing, 1 week	50– 90 per cent. killed
Storage after freezing, 2-4 weeks	90– 99 per cent. killed
Storage after freezing, 3-6 months	99–100 per cent. killed

While these figures are quite comforting, they apply only to the bacteria frozen with the ice. Bacteria in wastes falling on the ice afterward, or coming into contact with ice afterward—dirty sidewalks, manure—or saliva-soiled hands of drivers, porters, and waiters—or bacteria in infected water temporarily cooled by ice, are not necessarily affected in number or virulence. In two instances epidemics have been traced to snow in or on which typhoid discharges lay for several weeks, and with the spring thraw ran into the water supply affecting a large percentage of the consumers.

It is, of course, difficult to trace diseases back to ice; ice is as evanescent as the "snows of yesteryear." Yet the above indicates that a real danger may be avoided by using only long-stored ice or ice made either from boiled or a chemically treated water. Even then ice should be carefully washed to remove all surface contaminations, making sure that none of the melting exterior is retained for use. Ice *in* foods is doubtless attended with some risk, and could we persuade ourselves to forego the "clink of the ice" our

digestive apparatus would also be spared the shock and inhibited periods associated with such chilling temperatures.

Methods of Testing Water.—The character of a water supply is sometimes indicated by color, odor, and by lack of clarity. These are far from satisfactory tests, however, as water that is bacteriologically very good and entirely safe may have fine earthy suspensions, a decided color (from soil or roots) or a most objectionable odor (due to harmless green algæ (G)). And water passing these physical tests may contain dangerous disease organisms. We need, therefore, other and more exact ways of testing drinking water.

This is sometimes done by chemical tests: (1) for the total amount of organic substance, ordinarily low in water; (2) for substances formed by undesirable bacteria in polluted water (*e.g.,* ammonia).

Bacteriological Tests.—There are also two ways of testing water bacteriologically: (1) by counting the bacteria present in a definite sized sample or unit of water; and (2) by showing that a given sample has in it certain undesirable or injurious organisms.

In the first way the bacteria are estimated by counting the number of colonies that develop in a Petri dish containing a given amount of the water to be tested (see plate count in Glossary).

The second test, that a given sample of water contains undesirable or dangerous bacteria, is usually made by adding small amounts of the sample to different kinds of media, selecting usually the media in which most bacteria will not grow, but in which the bacteria for which we are on the lookout will outgrow all others or will grow in characteristic ways. Using such media, we can sometimes show that typhoid or cholera organisms are present.

The intestines of practically all domestic animals contain an organism known as *Bacillus* (or *Bacterium*) *coli.* *B. coli* is not present in unpolluted water.[4]

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[4] Investigations showed *B. coli* in but 2 of 58 wells (and in but 5 of 21 stagnant pools). If this organism is found in water, it is taken as an evidence of pollution, even though human disease organisms are not demonstrated. Typhoid organisms could hardly be found in water without the more numerous colon bacteria. Absence of the colon bacteria, therefore, would indicate a probable freedom from typhoid organisms. Such tests, called presumptive tests (G), are given more weight than estimates of the number of bacteria present.

It is impossible to give any satisfactory figures for judging of the safety of water. A high count indicates only that a large number of bacteria are present, and tells us nothing of the kind—harmless or harmful.

For the kinds of bacteria present we have to rely on the presumptive tests (G). As Park puts it: "The absence of colon bacilli in water proves its harmlessness so far as bacteriology can prove it. . . . In delicacy the colon test surpasses chemical analysis; in constancy and definiteness it also exceeds the quantitative bacterial count." A large number, however, indicates one of two things: (1) heavy and recent pollution, as by sewage, or (2) a large amount of organic material which, while not necessarily dangerous (manured fields), is objectionable and also capable of supporting the multiplication of bacteria. Reliable authorities consider 100 to 200 bacteria per c.c. (G) the limit to be expected in well waters not receiving surface pollution; and waters containing more should be treated to reduce the number to at least 100 per c.c. before they are used for drinking purposes.

Bacterial Content of Various Waters.—Ground filtered waters, such as wells, and quiet waters, such as lakes, have a rather low bacterial content. River water varies greatly, mainly because of the differences in organic wastes draining or emptying into it (*e.g.,* manured fields, city sewers).

The various types of water (wells, cisterns, lakes, rivers, springs) differ greatly in their opportunities for pollution and in their bacterial content; there is almost an equal range in any of these groups. To illustrate, well water is usually less than 200 per c.c. in its bacterial count; but wells may have thousands per c.c., and the death rate from one well has in known cases been greater than that of all the other water used by the rest of the community; one London well had a record of over 700 cases of cholera.

Suspicious water should be reported to the proper authorities, the local health board or more often to the State board. Samples for examination should be taken by them—or under their direction—as the origin of the water and recent history (floods, etc.) affect greatly the interpretation of the laboratory results. Samples should be taken when they can be examined promptly, as their numbers may increase or decrease on standing (standing raised a count of

7 per c.c. to 485,000; in another case the count fell from 535,000 to 54,500).

The various types of water differ in their physical and chemical qualities as well as in their bacteriological content. The most important of these relations are discussed in the following paragraphs.

Rain and Cistern Water.—Small amounts of rain (or snow) are sometimes collected on roofs, or specially constructed areas, and stored for use (*e.g.*, cisterns). Such water has in it certain chemical impurities absorbed from the air, *e.g.*, carbon dioxide. Besides, may be found such mineral substances as common salt (from ocean spray), nitric acid (from factories), and sulphuric acid (from burning coal).

Such substances lead to the changes observed in water held in metal tanks, making an inert lining[5] (*e.g.*, asphaltum) advisable for the tanks, cisterns, and delivery pipes. The use of lead for tanks is dangerous; and even for delivery pipes it is very questionable, although some water companies still insist that a lead pipe should be used between the main service pipes and the water meter. (This is required because of the effect of disintegrating iron on the mechanism of the meter.) When the house is a long way from the street main, the consumer may suffer from lead poisoning.

Water and snow wash out of the air suspended particles also; in fact, the formation centre of a droplet of water, a snowflake, or a hailstone is usually composed of particles of dust or bacteria. The bacteria are rarely numerous enough to be a menace; even if of the types that will multiply in rainwater tanks, they are usually not of the kind that cause disease in man, and the slight amount of organic material in clean rainwater would not aid in rapid multiplication of such organisms. If the collection area is not clean (*e.g.*, birds roosting on the edge of the roof or nesting in the gutters), the water may be highly polluted with organic matter. The organisms from such sources are not considered injurious to man,

[5] Cement or bricks make a better cistern lining than mortar; the lime in the latter tends to make the water hard. Lead is corroded readily by free acids in the water; oxygen with water has also great corrosive power. Iron is affected by such substances as nitrates, organic and mineral acids: zinc is also easily corroded, and is charged with causing chronic and obstinate cases of constipation.

but such water is not *clean* water, and besides being unattractive, often, in color and taste as well as association, it may, because of its organic content, afford nutrient material for other harmful organisms that may later enter the cistern through imperfect covers, pump floors, or broken side walls (Fig. 29). A still greater danger is found in open cisterns (or other tanks, such as roof tanks) which allow mosquitoes to breed in the water. Malaria and yellow fever are both carried by mosquitoes, which breed rapidly under such conditions, and many hotels and private houses thus supply

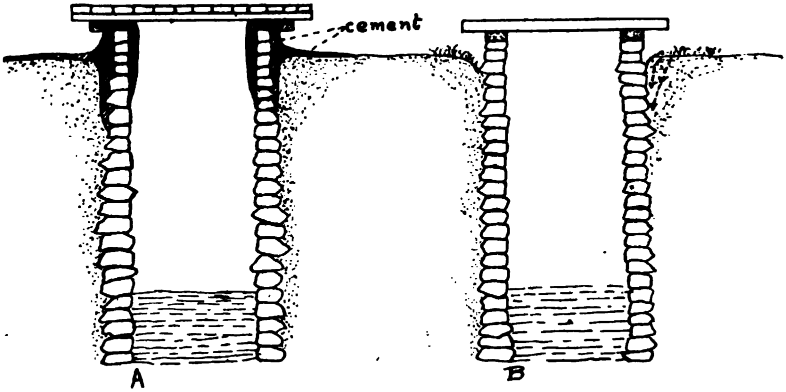

FIG. 29.—Two wells, both of loose-stone construction. One has a double floor and a cement rim all around the exposed part of the wall spreading out 2 to 3 feet around the well. What advantages does it possess over the one on the right?

themselves as well as their neighbors with a constant succession of mosquitoes.

Surface and Soil Water.—Most of the water that falls to the surface of the earth is not caught in cisterns. It travels appreciable distances as surface water or soaks into the ground. This ground water which penetrates the earth's surface may appear more or less promptly as springs (on hillsides, in the beds of other streams) or join other surface water collected in streams, rivers, lakes, oceans. Such bodies of water contain bacteria and organic matter as well as inorganic material characteristic of the area over (or through) which they have passed.

The acids mentioned earlier as acquired from the air, including carbonic acid, derived from the CO_2 of the air and soil, may help

dissolve minerals in the soil, and the "soft" rainwater (containing no alkaline earths) may become "hard."[6] Hard water is sometimes injurious to the skin of workers who must keep their hands in it for long periods; it makes such processes as dish-washing more expensive, as it takes more soap to produce a satisfactory cleansing lather (four to eight times as much.) Certain vegetables are said to be affected by the hardness of the water in which they are cooked, becoming thereby hardened and less digestible. In factories, hard water may form deposits inside boilers, etc., injuring them or demanding expensive removal processes.

Other minerals may be found, some of which give to certain waters their characteristic tastes or therapeutic reputations; sometimes peculiar or objectionable tastes are very prominent; there is, however, little evidence that any waters that people would drink contain sufficient amounts of any harmful mineral to be injurious.[7] It is, however, true that changes from hard to soft water, or from soft to hard, *may* cause digestive disturbances, and constipation or diarrhœa.

The surface water which finally collects in streams, lakes, etc., is, as already stated, characterized by bacterial and other organic matter from the surfaces covered or drained (decaying plants and animals, manured fields, the accumulations of private or community sewers). Bacteria in such water are killed off rather rapidly by such natural agents as oxygen and sunlight.

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[6] Hardness depends mainly on the amounts of magnesium and calcium salts in solution. The "hard" elements make new combinations with the soap and prevent the formation of a lather until they have been satisfied. Heating expels CO_2 and so may help by indirectly causing precipitation of substances that otherwise make the water hard. The addition of lime when the hardness is due to chalk or magnesium is an economical way of removing hardness in such waters, as a "few cents' worth of lime will remove hardness demanding many dollars' worth of soap"; limewater additions, however, do not reduce hardness caused by certain other substances. Sodium compounds are often helpfully employed in certain types of water. Such variations make a particular brand of hard water soap very valuable in some communities and quite useless in other localities.

[7] There is probably no foundation for the belief that gallstones are produced by certain types of hard water; the use of certain wells in Europe to produce goitre and so escape compulsory military service is probably equally mythical; the endemic character of goitre is still not completely explained, but it is most probable that the explanation of its endemic character is not *directly* a question of hardness of the water.

The rain or snow water which passes *into* the soil percolates rapidly through sandy or porous soils, slowly through clay soils, and finally reaches the level of free water (ground water) found deep in all soils. In some soils free-flowing underground streams may be found far underground; *e.g.*, in limestone regions where CO_2 absorbed from the soil forms carbonic acid which dissolves the limestone rock; or similar channels may be worn in a sandy soil by accumulated water which cannot penetrate the tightly-packed clay layer just below it. Even where there are no free flowing underground channels, there is a rather constant movement of the ground water in all soils, following the general slant of the water-holding layers. This explains why a well may cut off the spring supply farther down the hillside; and why wells near salt water (seashore, salt lakes) may be fresh, not salt.

Bacteria in Deep-ground Water.—Deep-ground water is comparatively free from bacteria. Most of the soil bacteria are in the uppermost part of the soil in a layer but four to six inches deep. Samples of soil taken four to five feet below the surface contain very few bacteria. Practical application is made of this fact when deciding the depth of the earth or sand filters used for our water supplies; they are commonly eight to ten feet deep, insuring thereby a margin of safety. Wells and springs that are supplied by deep-ground veins have, therefore, a low bacterial count, less than 100 to a cubic centimetre, usually. Higher counts indicate that surface water is washing into the well (Fig. 29), or that organic material has found access in some other way, *e.g.*, cesspools (Fig. 30). The bacteria that cause human diseases do not ordinarily live long in soil, and would, therefore, be but rarely represented in the deeper soil waters. Cemeteries are not ordinarily considered a menace. Water supplies are not collected from such areas directly, and the filtering power of the soil prevents passage of pathogenic bacteria to the deeper soil waters.

Deep Wells.—Artesian or deep bored wells take their supply from great depths; often sixty to one hundred feet, and not uncommonly a few hundred feet down. Such water usually contains but a small number of bacteria. If the bacterial count is high, or the water changes quickly in amount or appearance (with dry weather or after rain storms), the water layer that has been tapped lies near the surface of the ground, and somewhere surface bacteria

are doubtless entering the well. Normally, artesian tube or bored wells deliver safe water. It is a common practice to bore down until a deep sandstone layer has been passed. Next is usually an impervious layer, such as clay, and the ground water which filters through the upper soil layers and the deep sandstone layer (which, strange to say, is almost as porous to water as sand itself) collects on top of the impervious clay layer.

The slope of these underground layers, and the proximity of other wells tapping the same water layer, limits the amount of water any well can furnish. A large city using only artesian water re-

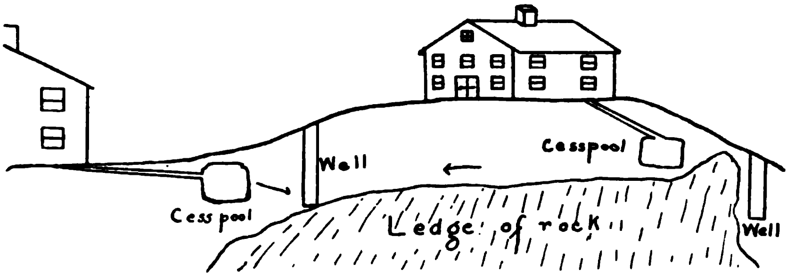

FIG. 30.—Note that the well on the left might be polluted by the cesspool apparently down the slope and also by material from the cesspool on the right, while the well on the right would escape pollution.

cently had to add a large surface or watershed area to its water system; the wells already in use were delivering all that the water-bearing layers could yield.

In every community there are those who object to the increasing cost of the water supply, contending that they "always have" used unfiltered water—or untreated water, as the case may be—and that their present unbroken record of health and longevity is evidence that what always *has* been is sufficient. These "always have's" are little moved when one patiently explains that the pollution is much greater now than formerly, and that we can no longer rely wholly upon such *natural* aids as sunlight, oxygen, or storage periods to destroy the bacteria, or upon dilution to lessen our chances of infection by them. As some one recently pointed out, the proper way to judge of unsanitary conditions is not by the healthy survivors but by the dead and fallen, by the illnesses and deaths of the rest of the community.

Purification of Water by Natural Agents.—Sewage-polluted streams are constantly having fresh and relatively unpolluted water added to them. Oxygen and sunlight are less important agents in reducing the bacterial count of water than formerly believed. A certain amount of oxygen is always found in unpolluted water (35 per cent.), but the amount is much less in polluted water (p. 152) even though wind-blown waters have their air (and oxygen) content constantly renewed. Sunlight's disinfecting action—both because of the effect of the chemical rays at the blue end of the spectrum and because of the power of sunlight to form H_2O_2 and thus liberate free oxygen—is not felt at any considerable depth. In rivers, therefore, dangerous organisms emptied into the river by one town may be so reduced in numbers or virulence that towns twenty miles down the river escape infection when using such water for drinking purposes, even when it is very incompletely filtered. Yet few reliable sanitary experts would recommend drinking such water, even after filtering, unless it were also chemically disinfected; the risks are too great. Marked decreases in bacteria counts due to these natural agents are reported by many investigators; for example, in a flow of ten miles a count of 48,000 per c.c. fell to 200 per c.c.

The Mississippi is often described as one of the best illustrations of the effects of these natural aids, for at its mouth, after having received for 3000 miles polluting material from all of the United States which lies between the Rocky and Appalachian Mountains, it is found to be comparatively free from intestinal bacteria.

Such statements, however, as that water "purifies itself every two hundred feet," or even every ten miles, are wholly without foundation, and should be emphatically contradicted. There are many unfortunate illustrations which flatly contradict such statements; for example, the typhoid epidemics at Lowell and Lawrence, or the typhoid death rate of Niagara Falls. An epidemic in Lowell, which discharged its sewage into the Merrimac, was followed by an epidemic at Lawrence, nine miles further down the river; Lawrence used the unfiltered river water for drinking purposes. This sequence of epidemics was repeated in two successive years, until Lawrence constructed a filter plant to filter the river water. Niagara Falls, sixteen miles below Buffalo, receives Buffalo's sewage in a few hours, and, therefore, before the institution of

filters and chemical treatment had the highest typhoid rate in the United States, 133 per 100,000.

Epidemics of typhoid have been traced to such conditions, even after years of comparative immunity; differences in water levels and the corresponding per cent. of pollution may at any time cause serious loss of life. The inadvisability of risking such chances of wholesale infection is evident; and no self-respecting community ought to submit to pollution of its water supply by up-river towns; still less should it discharge its own untreated sewage in a way to menace its neighbors (see Sewage Disposal, p. 152). A lake-town may similarly pollute its *own* water supply, as well as that of neighborhood towns.

Sedimentation and Storage.—Sedimentation is another method of improving the water supply, and occurs in conjunction with the natural agents previously described. In practice, sedimentation and storage are so commonly combined in our efforts to improve the quality of water, that it seems simpler to discuss sedimentation with storage. It is well known that rapidly moving streams are usually muddier than slow flowing ones; that lake water is clearer than river water. Small as bacteria are, they are relatively heavier than water, and unless buoyed up by water currents, they tend to sediment out of the water.

Since water itself is not usually rich in organic material, bacteria do not multiply rapidly in it but tend to die off. (They are constantly being replaced by surface washings, etc., and, so, brooks and rivers are never free from bacteria.) Water for city use, therefore, is often held weeks or even months in large reservoirs; during that time the bacteria sediment out (remaining behind when the water is drawn off), and many bacteria die for lack of food. Freezing generally hastens the death of bacteria; the penetrating sunlight aids also, though in open reservoirs sunlight may favor the growth of various green water plants (mainly algæ) and lead to the accumulation of undesirable gases or odors. (Aëration by forcing large amounts of air through the water as it leaves the reservoir, is a common method of removing such accumulations.) In small communities where thorough filtration entails too great an expenditure of money, good results are obtained by storage, especially where two or three reservoirs are used in sequence, thus insuring a long storage period. Boston boasts a thirty-day storage

period; a still longer period, thirty-five days at least, is given the Catskill water supplied to New York City.

Filtration.—Our discussion of the bacteria in soil waters has shown that an important "natural" method of improving the water supply is filtration. Normally, the soil holds back most of the bacteria in the water which passes through it. But no one would expect soft, water-soaked ground, or soil saturated by the manure

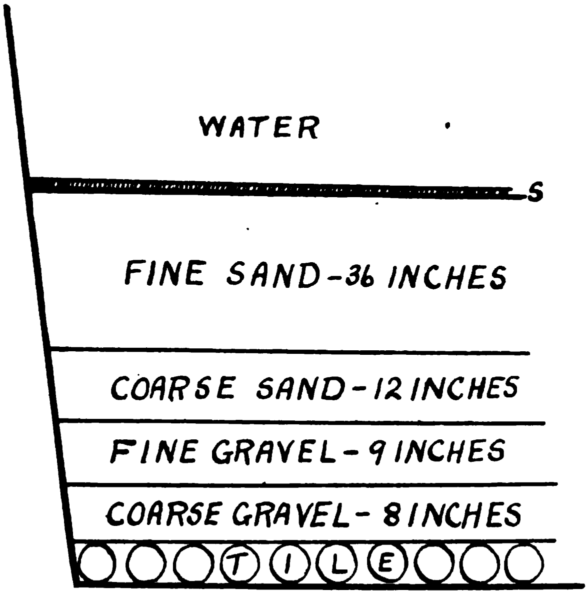

FIG. 31.—Water filter, showing layers of the various materials used. Note the collecting tiles at the bottom, and the slime layer (s).

accumulations of years, to be effective filters. In specially constructed sand filters (Fig. 31), through which millions of gallons of water pass daily, the top may become covered with a gelatinous mass of organic material [8] which for a time helps filter the water, but, increasing in thickness, finally delays the passage of water.

[8] This film increases the efficiency of the filter at first. Its formation is sometimes assured by using a coagulant in the water (*e. g.*, aluminum sulphate). This helps to clarify the water as well.

Such sand filters need to have the top layer scraped off about once a month, and should be dried and aërated between the filtering periods. Two or more filters used in sequence make proper cleaning and aëration possible. See intermittent filtration under Sewage Disposal (p. 156).

House Filters.—Wonderful as some of the stone and porcelain filters are at their best (removing 99 to 100 per cent. of the bacteria) there are none adapted to household uses for one or more of the following reasons: (1) Because they hold large amounts of unfiltered water in contact with the held-back organisms at warm room temperatures; (2) because organisms grow through the filtering material and pass out with the filtered water; (3) because they need to be cleaned (scrubbed and boiled) frequently; or (4) because they deliver water so slowly that servants and others using them will not spend the requisite time in collecting water, and either loosen the joints or add other water to the filtered supply.

House filters should not be made of animal charcoal, as bacteria may grow in it. Charcoal has too high a place in popular estimation due to its affinity for organic matter, thus clarifying the water. The improvement in appearance has, unfortunately, no relation to the bacterial content.

Self-cleaning house filters are not reliable. Some may be used for two or three weeks without cleaning (scrubbing, and boiling), but others are good for but two or three days. No self-cleaning or reversible filter ought to be used just after reversing the flow, as the pent-up bacteria and sediment are discharged when the flow is reversed. Like all other filters, they may not become fully efficient until a film of sediment and bacteria has been deposited on the filtering substance.

Park says: "Water which requires private filtering should not be supplied for drinking purposes. Unhappily it often is."

A simple and safe method, if the water supply furnished by the city is not clear or not bacteriologically safe, would be to boil the water to kill pathogenic bacteria and then filter it through some type of cotton-pad filters to remove sediment, etc. There are at least three types on the market which can be fitted on water coolers, etc., costing $0.50 to $1.00 each (with pads at one to three cents). These have a distinct advantage in that they are easily cleaned; the cotton pads should be replaced daily.

Heat.—Probably the simplest method of rendering water safe is boiling. A temperature of 80° C. (176° F.) for one minute kills practically all the organisms pathogenic to man. Boiling [9] (100° C. or 212° F.), therefore, makes doubly sure, and does away with the need of a thermometer. Heat is not used on a large scale in improving public water supplies, though Jordan has recommended subjection to a lower pasteurizing temperature (60° C.) for a longer period of time. In many cases it would seem possible to devise a scheme, especially where water towers are used, for passing the outflow from the reservoirs slowly through a heated chamber or area (chimneys, etc.), and thus rendering the water safe. In properly constructed plants, heat could act continuously; this would be better than the periodic addition of disinfectants, and would not have the risk attached of water stored too short a time, or incompletely filtered, or it might well be made a permanent addition to other measures for improving the water supply.

Purification by Chemicals.—Sometimes bacteria in water are killed by adding chemicals. Copper sulphate, popular some years ago, has been replaced by certain calcium or sodium compounds known as hypochlorites, and often popularly called "bleach" or "chlorides." (They are not chlorides, but differ materially in their composition; for example, calcium chloride is $CaCl_2$, and calcium hypochlorite is CaO_2Cl_2.) The hypochlorites are much stronger disinfectants, due probably to the fact that they are much less stable compounds, liberating both oxygen and chlorine, and both of these gases are strong disinfecting agents; most authorities agree that the main value lies in the oxygen liberated. The chlorine liberated is mainly valuable because it causes chemical changes which liberate more oxygen. Hypochlorites are added to the water in coarse powder form, and are effective in very small amounts, one to two parts of powder to a million parts of water, depending upon the condition of the water, *e.g.*, organic matter or bacteria present. In ordinary water the bacteria are reduced 99 per cent. by such treatment.

[9] Directions usually say boil ten minutes. This is to insure its really reaching a killing temperature. Many people, strange to say, do not know when water is really boiling. The flat taste due mainly to the lack of air can be removed by beating the water with an egg beater or by pouring the water back and forth from vessel to vessel. (Such vessels should not contain or be wet with unboiled water—or the value of the whole process is lost.)

Introduced but ten years ago in treating water receiving the Chicago stock-yard discharges, the hypochlorites have grown rapidly in favor and are still deservedly popular for treating water supplies and swimming pools (see Appendix).

"Bleach" deteriorates rapidly when exposed to the air; allowance must be made for this in estimating the amount to be used. These amounts are far below the amounts that can be detected by taste. In reservoirs and swimming pools with a continuous intake, the "bleach" must be added at intervals sufficiently spaced to insure sufficient action. Storage reservoirs, of course, need to be treated but once with each filling.

Another oxygen treatment strongly advocated from time to time is the form of oxygen known as ozone (O_3). Ozone has a strong bactericidal value (99 per cent.), but its value is affected by the fact that organic matter unites with it, and that it may give unpleasant tastes, or lead to digestive disturbances. The necessary electrical apparatus is complicated and far from "fool-proof;" another disadvantage is that unused ozone corrodes the water pipes. It cannot compete with the later and deservedly more popular addition of chlorine and hypochlorites. (See Appendix for home uses.)

Liquid chlorine, more recently introduced in treating large quantities of water, is just as effective as "bleach," and acts in much the same manner. It may be secured in small tanks for private or institutional use, and it has some advantages over "bleach"; it does not deteriorate, objectionable tastes or odors are less common, it is simpler and often cheaper to set up and operate. Our largest cities are using either chlorine or hypochlorites with satisfactory results: among them are New York City, Buffalo, Baltimore, Chicago, and Philadelphia.

One of the new methods which promises well is the using of the strong chemical light rays—the ultra-violet rays. With the right kinds of apparatus (*e.g.*, quartz globes instead of glass globes for the "lamps," as glass limits the passage of the rays) very efficient action is secured: in clear water most of the bacteria are killed in one minute. One or more lamps are placed in small tanks or outflowing chambers, and 50 to 200 gallons per hour may be treated by each lamp.

The following table, taken from a report of water supplies in

New York State, illustrates the beneficial effects of some of these ways of treating water:

City	Present water supply	Typhoid rate per 100,000 population for period before the change ranging from 4 to 23 years	Change	Typhoid rate per 100,000 population since change through 1915 (3-15 years)
Albany	Hudson River	89	Slow sand filters; hypochlorite	20
Binghamton	Susquehanna River	50	Mechanical filters	12
Cohoes	Mohawk River	89	Mechanical filter; hypochlorite	28
Ithaca	Six-mile Creek	78	Mechanical filter; hypochlorite	19
Lockport	Niagara River	57	Changed from Erie Canal to Niagara River	33
		33	Liquid chlorine	8
Niagara Falls	Niagara River	128	Mechanical filters; hypochlorites	29
Ogdensburg	....	50	Slow sand filters	16
Schenectady	Large wells intercepting ground water flow to river	86	Discontinued use of Mohawk River	11
Troy	Surface streams and lakes	56	Discontinued Hudson River part of supply	24

Amounts Necessary.—The large amounts of water consumed in our larger cities—one hundred to two hundred and fifty gallons daily per person—makes it quite difficult to supply such large amounts of high quality water without great expense to the community concerned. The figures for most European towns and cities are well under seventy gallons per person, usually less than forty or fifty gallons; even London has a per capita consumption of only forty gallons per person. The differences in water consumption do not always indicate different standards of cleanliness. They are more often due to the following causes: (1) Large consumption by manu-

facturing plants; (2) a wide difference in the amounts used for community measures, such as street-cleaning, disposal of sewage by water carriage, fire-protection, and public parks; (3) large estates with well-kept lawns, etc., may swell the per capita rating when compared with the strictly household uses in many towns and cities; (4) leakage in the water mains due to leaking joints, defective (hydrolyzed) pipes (10 to 50 per cent. loss); (5) the difference due to the methods of sewage disposal: by private privies or cesspools or by a more extended water-carriage system, including street as well as house sewers with final disposal at a distant point; (6) loss in the houses, factories, etc., due to leakage or carelessness. This last accounts for much of the difference. Dripping faucets and imperfect valves (*e.g.*, in boilers and toilet tanks) account for much of it; and constant running to prevent freezing often balances the increased summer consumption (bathing, grass-sprinkling, etc.). These, and other less excusable forms of carelessness are common where the cost of the water is not charged to the consumer on the basis of the amount[10] consumed. Metering the water supply commonly results in a 50 per cent. reduction in any community. While it is difficult to allow fairly for the commercial demands, water company records for metered areas for many small towns show but a 40 to 50 gallon per capita consumption, even when the watering of lawns, gardens, etc., is included; it seems fair to consider 80 to 100 gallons per capita sufficient for the average town, including in that amount also the civic water supply. More than that increases the living expenses unduly (whether paid directly by the consumer, or indirectly in taxes), and does not necessarily improve the sanitary conditions of the community or the health of the individual; and the saving to the community might well go toward other hygienic improvements not so generally conceded by the taxpayer as is the demand for good water.

Cost is an important consideration, but the amount of water is

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[10] Less satisfactory is the practice of charging according to the number of outlets per house.

itself limited. The rainfall (collected in rivers and lakes) and ground water (springs and wells) are often insufficient to meet the amount demanded by a community.

Even where the amount is sufficient (*e.g.*, rivers) its condition (commonly heavily polluted with sewage) and the large amount needed (street flushing, fire prevention, park uses, and irrigation) often make water unduly expensive.

It has been suggested that a double water supply might solve the cost problem, a good potable water being supplied for drinking and general household purposes, and a less costly water (river water for civic uses, fire, street washing, etc.). This method is at present used in several European cities (*e.g.*, Paris). If this latter supply for commercial and civic uses were treated in a way to render it safe (adding hypochlorites or chlorine), or unattractive for food and drinking purposes (by affecting the color or taste), there could be little objection to the double supply.

There are, on the other hand, strong arguments for a minimum water rate which will allow sufficient water for ordinary family use. The very poor tend to cut down too much the water consumption. This is distinctly a disadvantage to the community, as too great a limitation predisposes to disease; this both directly and indirectly affects the health of the whole community.

Bottled Waters.—Bottled drinking waters are of two main kinds: (1) Distilled water to which the bottling firms add minerals "to taste," and (2) natural spring waters. The former are usually bacteriologically safe, though there are on record occasional cases of mishandling, such as illicit refilling of emptied bottles. Charged waters are "charged" with gas, often CO_2 gas. Such charged waters are often sterile.

Waters from various springs containing water of attractive taste or real or imagined therapeutic values form the other type of bottled waters. There is a tendency to use much the same names for distilled and for these natural waters—commonly some combination of "Lake," "Spring," or "Hygeia." The safety of such waters varies with the hygienic conditions of the spring and the bottling processes.

Too often the spring is an unprotected hole in the ground subject to surface washings, open to children and domestic animals

(Fig. 32); the bottling is often done most carelessly—sometimes by children! These natural waters are subject to the risks already mentioned from improper handling after bottling. Patrons should insist on being supplied with bottles with unbroken seals.

Those using bottled water can usually secure from the city or State department of health a report regarding the safety of the water in which they are interested; in some cities the sanitary code defines definitely the grade of bottled water that may be sold. In

Fig. 32.—A spring from which water was bottled for sale. Note the opportunity for surface drainage from the road and house just above the rough shack surrounding the spring.

New York City the restrictions are very definite: "It shall be the duty of every manufacturer, importer or other person who manufactures or imports, in the City of New York, any artificial or natural mineral, spring or other water for drinking purposes, to file, under oath, with the Department of Health, the name of such water and the exact location from which it is obtained, together with the chemical and bacteriological analysis thereof, and when manufactured, the exact formula used in its production, giving qualitatively and quantitatively each and every item entering into its composition. No person shall manufacture or bottle mineral, carbonated or table waters, in the City of New York, without a permit from the Board of Health."

PROBLEMS

1. What is the source of the water used in your town? What means (storage, chemicals, etc.) are used to make it safe? How often is it tested as to its chemical and bacterial condition?

2. How many of your public buildings (schools, railroad stations, etc.) still use or allow public drinking cups?

3. To whom can your community apply to ascertain the cause of "hardness" in your water supply and the way it can most economically be reduced?

4. To what public official in your city (or State) can you apply for a free test of the public drinking water from a bacteriological standpoint? Can private supplies be tested also?

5. Are the swimming pools, wading pools, and other public bathing places in your community safeguarded in any way?

6. Write a popular argument designed to secure sanitary control of swimming pools, bathing places, etc.

7. What is the source of your local ice supply? Do you consider it safe?

8. Debate the advantages of a metered water supply *versus* a minimum charge per family.

See Reference List at end of Appendix.

CHAPTER VI

AIR AND VENTILATION

Introduction.—The supreme importance of fresh air is not to be questioned, yet there is no phase of our environmental relationship so little understood nor so misunderstood. Most people even to-day think only of the chemical constituents of the air (*e.g.*, oxygen, carbon dioxide) and fail to recognize the greater importance of its physical condition, *e.g.*, temperature, humidity.

Important scientific commissions in the United States and Europe have tested the effects of various combinations of atmospheric characters (*e.g.*, different percentages of oxygen, humidity, and temperature) on human subjects confined in specially constructed chambers in which the conditions could be modified at will, and there is no doubt that the three primary factors affecting our comfort are temperature, humidity, and air movement. The movement of the air is, of course, important only because it brings to the body layers or masses of air differing in humidity or temperature.

Bacteria in Air.—The bacterial content of the air has an important bearing upon health. It is, perhaps, the simplest of all the relationships of air, and may, therefore, be discussed first, especially as it bears little direct relation to the other factors.

The bacteria in the air come mainly from the soil, plant and animal decay, fermenting substances, and animal discharges (saliva, fæces). Bacteria do not ordinarily multiply in the air, for a liquid or semi-liquid medium is usually necessary, such as milk, cooked foods, blood, and plant or animal tissues. While it is conceivable that growth might continue for a time in such substances as expectorated masses of sputum, the air is a place where bacteria diminish in number rather than increase. The rate at which they disappear from the air would depend upon conditions met there. Extreme cold, intense sunlight, and lack of moisture tend to hasten the death of air organisms. Under favorable conditions over 90 per cent. of the bacteria may die in twenty-four hours; this would not be true of spore-bearing organisms, nor of bacteria covered by

phlegm, etc. Their own weight, minute as they are, causes them to "sediment out" of the air, though rapid movements of the air tend to retard their settling to the earth, where they are caught and held by wet surfaces, *e.g.,* lakes. Their suspension in the air is also prolonged by lint or dust particles, which may act as floaters or buoys. Rain, snow, and heavy fogs wash out of the air not only bacteria, but also floating particles which favor their suspension.

Reviewing the statements in the last paragraph, it will be easily understood why the bacterial content of the air varies with the locality, lower counts [1] per cubic foot being obtained in the first of each of the following paired situations: high and low altitudes; country and city; ventilated rooms and dusty streets; ocean and land; moist and dry climates; after and before rain storms. The range in number is very great; often none at all in a cubic foot on a mountain top or glacier or at the seashore, and thousands (10,000 or more) in a cubic foot in crowded, dusty rooms.

Transfer Through Air.—Most of the bacteria in the air are harmless to man. Even where the number reaches hundreds and thousands per cubic foot, one may breathe such air without acquiring any specific infection. It is estimated that under normal conditions about 300,000 bacteria are taken in per day in the inspired air. The tissues, therefore, have enough to do in disposing of the average number of air bacteria without subjecting them to increased work by breathing air heavily charged with bacteria. Many bacteria are mechanically removed from the inspired air by the nasal secretions, many are carried by food and mucus on down into the intestinal canal, but many are possible agents of evil, adhering to the nasal, pharynx, tonsil, and lung membranes. Many are doubtless oxidized (G) in the lungs, and some of the cells composing the fine air sacs or alveoli are quite like the white corpuscles in their

[1] The bacteria in air are counted by pumping through some kind of collecting or filtering substance (such as water) a given amount of the air to be tested (*e.g.,* one cubic foot, one cubic meter). The bacteria and other solids are thus collected, sedimented by allowing the water to stand, or by centrifuging (G) it, and the sediment is used to make an agar (G) plate which is incubated for two or three days to allow the bacteria from the air sample to develop into colonies. A simpler, but much less satisfactory, method of estimating the bacteria in air is to uncover a plate of agar for three to five minutes, and then close and incubate the plate. Air currents alone modify the results obtained by *this* method so greatly that it is not an accurate method of testing air.

destructive effect upon bacteria, having the same power of engulfing and digesting bacteria.

Forcible expiration, such as loud whispering, coughing, and sneezing, discharges into the air small particles of saliva, mucus, etc., rich in bacteria. Considerate people prevent the wide distribution of such bacteria by covering the mouth with the hand or handkerchief. This implies numerous fresh handkerchiefs, frequent washing of the hands, etc. It is little protection to society to so cover the mouth, if the unfortunate offender otherwise forces on his neighbor or family direct contact with the undesirable organisms (sore throat, pneumonia, colds, etc.) by careless handling of dishes, food, or their personal belongings, such as handkerchiefs.

Usually but a small proportion of the bacteria found in air are able to cause disease in man. This, of course, may not be true of air heavily polluted by the discharges of the sick (*e.g.*, sputum from the tubercular, nasal excretions of those beginning with measles). In crowded places, such as cars, a sneezing neighbor may so pollute his immediate environment (within a radius of ten to twelve feet or more when air currents favor such distribution) that he is a serious menace to those near him, since live and vigorous organisms may be thus directly planted upon the nasal and throat membranes of his neighbors. Such bacteria may by some be considered "air-borne," but they are practically transferred by direct contact. There is great doubt whether any diseases are really air-borne, though smallpox and measles, about which little is definitely known, are still sometimes classed as air-borne. In fact, bacteria are so short-lived in air that the dangers of transfer by air in home and hospital have been greatly exaggerated (see pp. 169 to 187).

Constant Temperature for Warm-blooded.—Man and other warm-blooded animals must maintain a relatively constant body temperature, despite great and often rapid fluctuations in the surrounding atmosphere. In man, but slight variations from the normal internal temperature of 37° C. (98° F.) are compatible with health, whether he is working in four shifts at the stoker's furnace at 121° C. (250° F.) or braving for months the cold of the Arctic regions at –46° C. (–50° F.). To retain the normal body temperature demands perfect correlation of the regulatory mechanism (including the nervous, circulatory, respiratory, and excretory sys-

tems) to the varying outside conditions; all this often in spite of the handicaps of insufficient or excessive food supply.

While it is really impossible wholly to separate temperature and humidity in discussing body temperatures, it seems advisable here to begin with temperature as if it were possible to consider them singly.

Normal Body Temperature.—Somewhere between 17° C. (62° F.) and 21° C. (70° F.) practically every normal individual finds his optimum atmospheric temperature. As this is very much lower than the average body temperature, 37° C. (98° F.), it indicates that in sustaining 37° C. as average, the body is constantly losing a large amount of heat, and therefore producing much more heat than is implied when we speak of 37° C. as the body temperature. And the increased heat production necessary when the body is surrounded by still lower temperatures—zero weather, for instance—must be very great, even though the usual elimination of heat from the body is then greatly reduced by extra or heavier clothing. At the higher temperatures of midsummer or of overheated rooms, the body efforts are in the opposite direction: heat production in the body must be minimized and the elimination of heat from the body must be expedited very greatly, if the body temperature is kept down to 37° C.

Heat is produced in the animal body mainly by the oxidation of food substances. This indicates the basal importance of food—not food *en masse* nor food in the alimentary canal merely—but digested food, or food in absorbable form which is distributed by the blood (and lymph) to all the living cells of the body. In each of these cells much of this food is oxidized by oxygen carried to them by the blood. This oxidation yields energy or the power to do work. The energy production is coincident with the production of heat. This heat varies with the amount of work done by those cells, and with the kinds of cells most actively employed: a resting muscle produces much less heat than one in action; less evidence of heat is obtained from extreme activity of brain cells than from even moderate activity of gland or muscle cells. It will, therefore, be clear that heat produced may not only be limited by the amount of food and oxygen available, but that it is influenced also by the work done.

Heat Loss.—Heat is lost or eliminated from the body in sev-

eral ways: first, by the elimination of such warm body wastes as expired air, urine, and fæces; second, by the evaporation of water from the surface of the body; third, by the direct passage of heat itself from the body. . The first is, of course, considerable, but it is more or less compensated for by the high temperature of certain foods when eaten (*e.g.*, hot soups). The second is more important. To change water to water vapor demands heat. A given amount of heat is necessary to vaporize a given amount of water, whatever the conditions: it may be applied quickly or slowly; it may be in visible form, as burning gas; or one may be unconscious of its presence and action, as the evaporation of water by the sun on a mild day, and the evaporation of water from the surface of the body by the heat of the body itself or by the heat of the surrounding air. Every twenty-four hours nearly two quarts of water pass from the body as insensible perspiration; the heat which vaporizes it, rendering it "insensible," is taken from the warm body or the air immediately surrounding the body. Insensible perspiration probably means a daily loss of nearly 500 calories (G). The third, the direct passage of heat *itself*, is commonly discussed in physics under three topics: conduction, convection, and radiation. The meaning of these terms forms the real basis of a complete understanding of heat elimination and conservation as well; they are also fundamental in understanding the applications of this question to ventilation.

Conduction.—Heat varies in the rapidity with which it can travel through various substances, from particle to particle. It travels quickly through iron and silver, slowly through air and glass. Iron is, therefore, a good conductor; air, a poor conductor. Similarly, linen is a better conductor than cotton and silk; to *conserve* the body heat, one would not choose linen for the clothing in contact with the skin. Since air is a poor conductor, a layer of air may make a warmer covering than textiles. To keep that layer of air unbroken, an outer layer of clothing is necessary. Several layers of clothing mean several such non-conducting air layers, each one hindering the passage of heat from the body. Instead of several complete layers of air, similar results may be obtained by a loosely-meshed material which has in its single thickness innumerable little air spaces; some types of underwear, sweaters, "hug-me-tights," and woolen textiles in general, owe their "warmth" to these air spaces. The layer of air next the body becomes somewhat heated

from contact with the body, by conduction. If the same "aerial blanket" can be maintained, the body heat loss is less than if new layers have to be heated at the body's expense. (This "aerial blanket" is often used in a broader way, meaning the general air layer around the body, clothing and all.)

Convection.—The air around the body, on becoming heated, is, of course, lighter, bulk for bulk, than the surrounding cooler air. It is pushed up or farther away by the heavier cooler air, thus forming currents called convection currents; this method of distributing heat is called convection. Since convection changes the "aerial blanket," it is, of course, a definite help in warm weather; but, even then, we prefer to break or replace our "aerial blankets" more rapidly or effectually by walking, bicycling, motoring, or by the use of fans, hand or electric. At times the replacing air may be so nearly the temperature of the former body layers of air that practically no heat is conducted from the body and no change of temperature is noticed. In walking, running, etc., the aerial blanket is rapidly broken or replaced, but the added heat caused by the muscular exercise may more than offset any small benefit so obtained. Convection is, of course, not a different way of removing heat from the body, being merely a way of bringing fresh layers of air to the body, each of these fresh layers removing heat from the body by conduction and by the evaporation of body moisture.

Radiation.—Conduction, and the subsequent convection, do not account for all the heat lost from a heated body. Heat may pass from a heated mass, not only in currents, but irrespective of them, or actually in opposition to such heat waves. Convection waves may be noticed *over* a stove or hot grate, but considerable heat passes out in all directions, *e.g.*, horizontally and downward, from that same heated mass, the heat travelling across or even against the convection waves. It may also be observed in a vacuum, where there is no air to act as a conductor, or form convection waves. The theory that the heat travels on the *ether* (G) waves accounts not only for this method of heat dissemination here on our earth, but for the passage of the sun's heat through space to the earth. Radiation, like conduction, decreases with a rise in temperature. At usual room temperatures conduction and radiation together account for about 75 per cent. of the loss of body heat, or about 1800 calories.

Adaptation to Low Temperatures.—When we are exposed to

low outside temperatures the problem is to conserve body heat: to lessen the conduction of heat, to hinder convection currents in removing the body-heated layers of air, and to check or decrease radiation. There is but one other alternative—to produce more heat in the body. This can be done by using the storage food (*e.g.*, fat), or by taking in more food. If the diet is already sufficient in amount and well-proportioned (*e.g.*, the right proportion of heat-producing foods), no great change should be made in the food supply, for there is great danger that a heavier food intake will overwork the digestive and related systems. The diet should always be modified according to the season, the work done, and the storage or reserve food that may safely be drawn upon; but modifications in dress, and a careful consideration of the length and extremity of periods of exposure, are more economical and also safer ways of maintaining the necessary body temperature than making heavy additions to th amount eaten.

Meeting High Temperatures.—At temperatures approaching and exceeding body temperatures the problem is the opposite of that just discussed. Effort is, therefore, made to favor the elimination of heat from the body. Good conductors (*e.g.*, linen) are preferred for clothing, especially that in contact with the body. The frequent or definite replacement of the air blanket is assured by leaving much of the body uncovered, by wearing fewer layers of clothing, and by the instinctive resort to fanning, seeking cooler corners, etc. Here, too, the result may also be affected by the amount of heat produced in the body. A lessened food intake means less oxidation. (Stored food, *e.g.*, fat, may, of course, be oxidized, if called for by exercise demanding more than the reduced food intake, and no diminution in heat production observed.) While reduction of diet may be carried too far, the cases of injurious voluntary reduction are few when compared with the cases of overeating.

Internal Regulation of Body Temperature.—Our discussion has implied that by such external mechanical devices we can consciously control our physical comfort in this matter of temperature adjustment. Yet the greater part of the adjustment is made through the involuntary activity of the nervous, circulatory, respiratory, and excretory systems. Without the constant coöperation of these closely correlated involuntary systems, though we con-

sciously devoted every minute of our time to meeting the various and varying external temperatures, modifying to this end our diet, our clothing, our body movements, and availing ourselves to the full of our knowledge of heat conservation and dissipation, we would not pass one comfortable hour in the whole twenty-four. As a matter of fact, before we are conscious that the temperature has increased or fallen, the nervous system has started compensatory correlated action in these systems. The skin capillaries may be contracted to lessen circulation in the skin and conserve body heat by reducing the amount of blood near the surface of the body and opportunities for conduction; or the skin capillaries may become enlarged (1) to allow greater elimination of heat from the body (and reduce the dangerously high temperature obtaining in the internal organs); or (2) to insure greater heat supply in the skin where the temperature may be dangerously low. Such skin changes are accompanied by changes in the rate of circulation and in the depth and rate of respiration. Increased or decreased blood supply in any region means increased or decreased cell food and oxygen, with proportionate changes in cell oxidation and heat production. The excretory system is directly affected; this is illustrated by the increased or diminished water output from the lungs and the skin.

The detailed discussion of these relationships belongs to physiology rather than hygiene. Some of us, however, may find it interesting to consider here such questions as the following: Why do such different causes as exercise, cold winds, and midsummer heat all flush the skin? In long exposures to cold, why is a dangerous condition indicated when the flushed skin becomes pallid? Does a hot or cold bath bring greater or more lasting relief from excessive summer heat? Does a person who doesn't perspire readily really feel the heat less?

Dress and Thermal Control.—While we cannot by taking thought add much to the compensatory power of these related systems, it is unfortunately within our power to lessen materially their prompt and complete response to the body needs. One may so nearly protect one's self from variations in external temperature by too heavy clothing or too many layers of clothing, or by "keeping housed up," that the skin experiences but few and slight changes in temperature, and practically loses its power to respond quickly to changing conditions. An overheated, covered skin often be-

comes flabby and moist; the chill due to this condensed moisture may lead one to think that his skin is particularly sensitive to cold, and that he would perish absolutely under normal conditions, whereas he would be much more comfortable with less clothing, or if he subjected himself more often to outdoor conditions. Old people (whose metabolic and compensatory processes are slowed), inactive people, and nervous invalids, may be commonly observed increasing their own discomfort by such prejudices. But less sympathy is felt for those whose blind adherence to style leads them to wear excessively heavy clothing indoors or throughout the summer. Just as men had acquired a fair degree of tolerance for the clean and attractive negligée shirt, women set back such common-sense customs indefinitely by the silly slogan, "No lady is seen on the street without her coat." Just as foolish is the constant wearing of sport coats and sweaters in overheated rooms and even in midsummer. No cut or color of outer garment can outweigh in any observer's eyes the evidences of bodily discomfort and often uncleanliness common to such inappropriately dressed people.

One other factor affecting heat elimination might well be mentioned here. Fat conducts heat less readily than other tissue. Those who have a definite fatty layer beneath the skin do not lose internal body heat as rapidly as those lacking such a layer. There are, in winter time, certain advantages in being fat. In summer, how would such a fatty layer affect one's comfort? Women have usually a more definite fatty layer than men. Many of the household disagreements as to the optimum house temperature may be traced to this difference, though, naturally, the relative physical activity of the various members of the household has a great deal to do with it.

Variations in Temperature Desirable.—Periodic and marked variations in temperature (indoors as well as outdoors) are most desirable. In that way only can the skin keep its power or habit of instant and full response. The habit of running outdoors without a wrap or hat for *brief* periods of time is usually better than a tonic in its stimulating effect on the body through its complex compensatory mechanism. The cold spray at the end of the shower bath is a common way of helping the skin retain its important function as a thermal regulator.

Humidity.—Having discussed temperature and its applica-

tions, our problem now is a relatively simple one, and consists of but two parts: (1) What we mean by humidity, and (2) how humidity affects the dissemination of heat from the body. Mixed with the air is a varying amount of water vapor. The amount depends upon the water available and upon the temperature. (It is customary to speak of air as "holding" water, though the amount of water in a given space is independent of the presence of air.) Roughly measured, air at room temperature, 17° C. (62° F.), may hold twice as much water vapor as air at freezing, 0° C. (32° F.), and three times as much at body temperature as at freezing.

The amount of water present in a given volume of air is called the absolute humidity. It is, for some reason, more common to measure humidity in terms of the water really present when compared with what it *might* hold at that temperature. For example, one cubic metre of air at 30° C. (86° F.) can "hold" thirty grams of water vapor. If in this space the air at 30° C. has but twenty-four grams of water vapor, its relative humidity is 80 per cent. Where the available water is limited (indoors, dry weather), there is often a great range in the relative humidity, often as great as 80 per cent. in a day. In most of our daily newspapers, relative humidity is given. The reading for January 28, 1918, New York City, is:

8 A. M., humidity 98 per cent.
10 A. M., humidity 88 per cent.
3 P. M., humidity 86 per cent.
6 P. M., humidity 96 per cent.

Since the temperature affects so directly the amount of water vapor in suspension, there are, throughout the day with the changing temperatures, constant changes in the amount of vapor held. Outdoor air commonly contains from 30 per cent. up to 100 per cent. (or saturation (G)). The amount may regularly vary as much as 80 per cent. during one day (relative humidity). In buildings, the water vapor is rarely condensed to water in sufficient amounts to attract attention (except on cold window panes). When the relative humidity reaches 80 to 85 per cent. it begins to show on the objects in the room. Room air is commonly very much drier than outdoor air. But the cold walls, while apparently dry, may hold large amounts of water, sometimes more than all the air space in the room. There is, therefore, a continued exchange between

such chilled water-holding walls and the room air. In cold snaps, the wall fixtures (doorknobs, bolts, plumbing) and the cold corners of the walls themselves sometimes become covered with a coating of fine ice crystals or a feathery, snowy mass, thus showing that much water is present on the walls, etc.

Effect of Humidity on Body Temperature.—The humidity of the air affects the temperature of the body in several ways: (1) Conduction takes place more rapidly as humidity increases. We have long recognized this, saying, "There forty degrees below zero isn't so cold as zero weather here, because it's dry cold," or "We feel the cold more to-day, because it's damp." More rapid conduction means more rapid heating of the air masses near the body and more active convection currents carrying the heated air away from the body.

(2) Radiation diminishes as the humidity increases.

(3) A third way in which humidity affects body temperatures is that it affects the evaporation of moisture from the body. Air saturated with water-vapor cannot (at that same temperature) receive any water vapor from the body. High humidity, therefore, lessens the evaporation of body moisture and therefore hinders the loss of heat from the body. A room that is too cold for comfort may sometimes be made quite comfortable by boiling water in the room, mainly because then, in the more humid atmosphere established, the body loses less heat by the evaporation of body moisture. (This apparently more than counteracts the increased conductivity of humid air mentioned above.)

In hot weather when atmospheric temperatures (indoors and out) are as high or higher than the body temperature, we get little relief by the conduction and convection of heat; but if the air is relatively dry, comparatively large amounts of body moisture can be changed to vapor, thus materially reducing the temperature of the body and of the air in contact with it. Such devices as sprinkling floors, wetting sheets, or other large areas with water increase the humidity, but they also reduce the temperature by the evaporation of the water, especially when an electric fan increases the air circulation, and therefore the opportunities for evaporation. A little less water may be evaporated from the skin, but this consequent reduction in the personal loss of heat is more than com-

pensated for by the general reduction in the air temperature and the increased conductivity of the air.

The Comfort Zone.—In life, humidity and temperature are, of course, coëxistent factors, and so must be considered together. Experiments with specially constructed observation rooms have shown that an uncomfortably warm atmosphere can be made more bearable by (1) reducing the temperature, or (2) decreasing the humidity, or (3) by increasing the rate of air movement. The New York State Commission on Ventilation showed that the same degree of comfort is obtained by reducing the temperature one degree, the humidity one per cent., or increasing the air movement twenty feet per second. For indoor temperatures (which are the only ones we really try to control) a "comfort zone" has been defined; the temperature lies between 13° and 21° C. (55° and 70° F.), and the humidity ranges from 30 to 55 per cent., a much lower relative humidity than that found in outdoor conditions. There, however, the temperatures are usually lower.

Effect of Types of Air.—In general, dry air is tonic and stimulating; so is cold air. Warm air is depressing and moist air is even more so. Dry, cool air is usually desired for outdoor conditions and has the tonic and stimulating effects attributed to both dry and cold air. In dry, warm air one is usually conscious of stimulating effects. Indoor air may be so dry that the evaporation of water from the body is rapid enough to produce chills; if 20° C. (68° F.) is not warm enough, the room humidity is too low and should be increased by boiling water, by leaving exposed trays of water on the radiators, or through growing plants (for moisture is given out from the soil and also through the leaves). Most of the efforts to supply sufficient moisture are not successful, because the water surface exposed is too small, whether water is placed in dishes on the radiators or in the water-boxes of the furnaces (see p. 143). In moist, warm air the heat is not lost from the body rapidly enough, the skin struggles to accomplish the increased amount of work left to it; the whole compensatory apparatus may be overworked (often adding definitely to the temperature discomfort), and unless clothing, exercise, and all muscular effort are decreased sufficiently to meet the situation, heat stroke may result. Disinclination to mental and physical work (sometimes also to eating) characterizes the human response to days or to localities unusually warm and moist.

Cold, damp air makes a greater drain upon the body, not because of anything inherently injurious in dampness, but because both dampness (humidity) and cold encourage heat loss unduly. While modifications in clothing and increased exercise may help somewhat in this situation, the usual resort is to a heavier food intake. This taxes practically all the important systems of the body, and may lead to various derangements of one or more organs (*e.g.*, heart, kidneys). The kidneys may be directly affected by overwork due to the lessened elimination of water from the skin. Certain diseases, *e.g.*, pneumonia, are more common in cold, damp weather, due either to a general lack of tone or resistance resulting from the above complications or to conditions not yet wholly understood.

Chemical Substances in Air.—We now come to a consideration of the chemical substances in ordinary air. Air is a mixture of several gases, oxygen, nitrogen, and carbon dioxide being the most important. There are also small and varying amounts of various other gases, such as ozone, hydrogen peroxide, argon, and methane. Other chemical substances, such as acids and salts, found in the air, will be mentioned briefly at the end of this section.

Constancy of Amounts of O and CO_2.—We know that oxygen is constantly consumed in large amounts in all oxidation and combustion processes, such as respiration, the burning of wood, coal, gas, and oil. As a result of this oxidation or combustion, carbon dioxide is formed in large amounts.

Sugar, oxidized in the human body, breaks up into carbon dioxide and water ($C_6H_{12}O_6 + 12O \rightarrow 6CO_2$ and $6H_2O$). Coal or any other fuel substances burned in a furnace have among their waste substances large amounts of the two products, CO_2 and H_2O.

The processes just described constantly remove from the air large amounts of oxygen and add to it large amounts of carbon dioxide. One would, therefore, expect to find great differences between the amounts of oxygen and carbon dioxide in crowded cities and unpopulated districts. Still more might we expect to find striking contrasts between the air analyses made now and those made over a century ago, when the total population was far less, and when the general use of wood, oil, gas, and coal in homes, and for transportation and manufacturing, was almost negligible. Nevertheless, the oxygen and carbon dioxide proportions in the air are practically the same that they were a hundred years ago.

That the air is so constant in its proportionate amounts of oxygen and carbon dioxide is mainly due to three things: First, the total amount of air is enormous, and our subtraction of oxygen and addition of carbon dioxide make very little impression upon the whole air layer—miles in depth—which surrounds our earth. It has been estimated that it would take 18,000 years to reduce the oxygen 1 per cent. Second, any gas diffuses rapidly throughout the other gases in this atmospheric mixture we call air. This diffusion is aided by the constantly changing air currents, *e.g.,* winds. It is only in poorly ventilated places, such as closed chambers and deep recesses, that we find marked increases in carbon dioxide, or strikingly decreased amounts of oxygen. Despite the large amounts of CO_2 given out by furnaces, etc., the air of towns does not differ markedly from the country.

Place	Oxygen	CO_2
Country air	20.94 per cent.	.0318 per cent.
City air	20.87 per cent.	.0385 per cent.

Third, green plants have the peculiar power of utilizing CO_2 in their manufacture of sugar and starch; in doing this, oxygen is eliminated by the plant. With living green plants, therefore, we have two marked effects upon the air; carbon dioxide is removed, and oxygen is added—twelve atoms for every molecule of sugar formed: $6CO_2$ from air $+$ $6H_2O$ from soil $\rightarrow$ $C_6H_{12}O_6$ (sugar) $+$ $6O_2$.

Every particle of green tissue in field, garden, or forest has this power. The millions of tons of sugars and starches formed each year by plants of commercial value (sugar cane, corn, oats, wheat) give but a partial idea of how much carbon dioxide is broken up and how much oxygen is released by all the green plants during their active periods. It is estimated that practically all the oxygen in the CO_2 is released; and some idea of the rate of exchange may be gained when we read that one square metre of leaf surface can break up all the CO_2 and free all the oxygen in 2500 litres of air every hour of sunlight.

Oxygen.—As already stated, the oxygen content of air varies little except in confined spaces. Inspired air may have an oxygen content of 20.8 per cent. to 20.94 per cent., and expired air, of 16.0 per cent. But this expired air is no more air, in the usual generalized sense, than are the gases one could collect in a factory

chimney. Even indoors the variation in oxygen content is surprisingly small. In the stuffiest bedroom, the most crowded classroom or public hall, the difference in oxygen content ranges only from 20.94 per cent. to 20.00 per cent.

Experimental work with people and other animals in closed chambers has shown that the oxygen may be reduced to 17 per cent. or raised to 50 per cent. without any evidence of discomfort or any disarrangement of the vital functions. A drop to 11 per cent. is dangerous, and a reduction to 7 per cent. causes death; but since these low amounts are not approached under ordinary conditions, it is easily seen that the oxygen content of ordinary air is not an important hygienic factor.

This does not imply that oxygen is not important *in the human body;* it merely means that, fortunately, the oxygen content of our *environment* is not ordinarily a matter requiring conscious adjustment.

The average person breathes in daily 34 pounds of air, or 7 pounds of oxygen, of which but 0.2 pound is absorbed.

In the blood, this absorbed oxygen is held both as oxygen and as a compound with hæmoglobin (G). About $\frac{19}{20}$ is held in the red corpuscles (as a chemical compound, oxyhæmoglobin), and about $\frac{1}{20}$ is held physically, in solution in the liquid part of the blood or plasma. As the plasma gives up oxygen to the cells, it draws upon the oxygen in the red corpuscles; the red corpuscles regaining their full storage content on their return to the lungs.

Ozone.—Ozone, composed of oxygen only, has a different grouping of its atoms, three being required to make a molecule (O_3). It is *popularly* spoken of as a synonym for oxygen: *e.g.,* "to fill one's lungs with ozone," and "where the air is pure ozone." But it is not the same as the gas (O_2) we have just been discussing. The different grouping of the atoms apparently makes it a more unstable substance, and it is a very active oxidizing agent; even minute amounts (*e.g.,* one part to a million) are very irritating to mucous membranes, while larger amounts (*e.g.,* 15 to 20 parts per million) are fatal to human beings, lessening the oxygen intake and the CO_2 eliminated, producing headache, drowsiness, depression, and finally, unconsciousness and death. Though traces are normally present in air, it is generally lacking in the air of inhabited rooms, and occupied districts (large towns); it is most

abundant in forested regions, and at the seashore. Ozone is produced by natural electrical discharges (lightning), by the oxidation of phosphorescent substances, by the friction of the ocean surfaces against the air, and probably by the activity of green plants. As found in air, it is not a valuable disinfecting agent, for it rarely exists in air in more than 1 or 1½ parts to a million, and bacteria are not killed until the amount equals 13 parts per million—a concentration injurious to man. Ozone is sometimes manufactured chemically and used to disinfect or to sterilize such substances as drinking water and dressings, but that is entirely apart from its value as an air constituent.

Hydrogen Peroxide.—Hydrogen peroxide (H_2O_2) is present in very small amounts in air, and may be demonstrated in rainwater and snow. It is an active oxidizing agent, because of the extra unstable O atom; but, in ordinary air, is probably not present in large enough amounts to have any real value.

Carbon Dioxide.—Carbon dioxide (CO_2) is still *popularly* considered as the one constant attribute of "bad air," although it is unimportant even in vitiated air. Carbon dioxide is present in all air in relatively small amounts, 3 parts to 10,000 or 0.03 per cent. In smoky air (which delays its diffusion) it may rise to 0.8 per cent.; in commercial processes it often reaches 0.5 to 0.7 per cent.; a strikingly high percentage is formed in active fermentative processes, as in breweries, where 10 per cent. may be demonstrated.

Evidences of its unfavorable effect do not begin until 5 per cent. has been reached, when the breathing may be rapid enough to be termed "panting"; with still increased amounts, the discomfort increases (headache, nausea), but 30 per cent. may be reached without loss of life, death occurring when the percentage reaches 35 to 50 per cent. Expired air contains 4.4 per cent. CO_2. Our average CO_2 output is 0.4 to 0.6 cubic foot per hour, increasing with ordinary physical activity to 1.0 cubic foot. This sounds as if the oxygen would soon be used up, and as if the CO_2 accumulation would rapidly become very great. But we must recall that the total amount of atmosphere, and the rapid diffusion of its gases make such depletion and accumulation very unlikely, even indoors; for our houses are far from being air-tight (see pp. 142 and 143).

The blood coming back from the tissues may have as high as 45

per cent. CO_2. It cannot lose *all* of its CO_2 in the lungs, for the percentage of CO_2 in the blood cannot fall below that on the air side of the alveolar membranes (G), usually 5 to 6½ per cent. (See Osmosis and Dialysis in Glossary.) It may not fall so low in the short time it stays in the lungs, though the time element is not so important as one would think, because of the immense amount of alveolar surface, recently estimated at over 100 square yards. A high percentage of CO_2 in the alveolar air will, therefore, limit or reduce the amount given off to it by the blood; blood leaving the lungs with a high CO_2 content will not be able to remove so much CO_2 from the tissues. Before this reaches a dangerous point, adjustment is made through the respiratory centre. A definite amount of CO_2 is necessary to stimulate the respiratory centre (which is situated in the *medulla oblongata* (G) at the base of the brain), to keep up the tone of the blood-vessels, and to regulate heart action. When the alveolar content exceeds 5 per cent. (more exactly, 5.3 to 5.7 per cent.), the respiratory centre is stimulated to increased activity (deeper or more rapid breathing, or both) and this better lung ventilation continues until the normal lower CO_2 content in the alveoli is secured. The slight increases in the CO_2 which are ordinarily met with in the outside air have little effect upon the alveolar content. They are negligible compared with the effects of re-breathing expired air (*e.g.*, head almost covered by bedclothes), which expired air commonly contains about 4½ per cent. of CO_2. The respiration rate or depth is changed to meet these differences, but so readily and so gradually that it is an unconscious adjustment. Even the greater adjustments necessary to meet the accumulating CO_2 from burning gas jets (3 cubic feet per hour), lamps, and stoves may be made without noticeable effort.

Exercise increases the amount of CO_2 formed in the body and carried to the lungs; this affects the amount of CO_2 in the alveoli, and, as shown in the preceding paragraph, leads to compensatory changes in the respiration and circulation rates, continuing until the former normal 5 per cent. CO_2 content of alveolar air is established. Lessened activity or sleep means that less CO_2 is formed in the tissues. When, therefore, the amount in the blood and the amount in the alveoli fall below the normal 5 per cent., respiration is slowed until the normal amount again exists in alveolar air. In

extreme and, fortunately, unusual cases, respiration may entirely cease for lack of CO_2, and it may be necessary to blow CO_2 into the lungs to start respiration. We are so accustomed to thinking of oxygen as the only essential gas in respiration, and have heard so often of oxygen as a reviving agent where respiration is slowed or difficult, that this, to some, seems almost unbelievable.

CO_2 Not an Index.—As CO_2 increases in amount in occupied rooms, there is also an increase in temperature and humidity. When investigators proved that CO_2 was itself not an important factor in ventilation, it was still thought that the CO_2 present might serve as an index of air vitiation. But CO_2 does not accumulate in a room in direct ratio with either heat or humidity, and cannot, therefore, be used as a determining factor in ventilation.

Carbon Monoxide.—The deadly carbon monoxide—dangerous at 0.2 per cent. and fatal at 0.4 per cent.—is sometimes confused with carbon dioxide. Carbon monoxide (CO) has but half the oxygen present in carbon dioxide, and is formed by the *incomplete* combustion of coal, charcoal, oils, wood, and fuel gases. It is usually, therefore, a problem of indoor air. Usually such incomplete products from coal stoves and grates make their escape unnoticed by direct draft through the chimney or by gradual diffusion through cracks, windows, etc. In winter, when more fuel is used and when the aëration of the room is less complete, cases of poisoning by this gas are more numerous. Night fires are most dangerous, partly because large amounts of coal are put on at one time (to last through the night), and partly because the chimney drafts are shut off (to slow the fire).

Carbon monoxide is found in illuminating gas, in amounts varying from 6 to 10 per cent. in coal gas to 30 per cent. in water gas. (The amount of CO in illuminating gas is limited by law in some States to 10 per cent.) Leaky gas fixtures may cause death; more often they cause sleep disturbances, such as repeated nightmares and hallucinations, and several "haunted houses" have regained their good reputation when the gas pipes were thoroughly repaired. Incomplete ventilation or aëration of rooms where large amounts of gas are used for water heaters or for room heating may cause large amounts of the CO in the gas to escape in that form. Long-used or uncleaned burners, bearing a charcoal crust, may form CO in sufficient amounts to cause illness or death. The ex-

haust of gas engines contains CO gas; and not infrequently the running of pumping, threshing or automobile engines in closed garages or buildings has caused death.

Carbon monoxide has such a high death rate for four reasons: First, its presence is usually unsuspected, as it is practically odorless. Second, it is injurious because, like CO_2, it represents tied-up oxygen which the tissues cannot use. Third, because carbon monoxide makes a stable combination with the hæmoglobin in the red corpuscles (carboxy-hæmoglobin) which prevents the red corpuscles (or hæmoglobin) from giving their oxygen to the tissues and from gaining more oxygen from the lungs. Fourth, carbon monoxide has the power of injuring certain cells, such as the nerve cells, thus causing paralysis of motor and respiratory systems and sometimes making it impossible even for those still conscious to escape from the presence of the gas.

Sewer Gas.—Sewer gas may have in it leakage from illuminating gas pipes, but the gases which cause explosions in dead ends or at manholes are more often due to gasoline accumulations from cleaning establishments, garages, or from the oily streets. (In most places, it is illegal to allow gasoline from garages and cleaning establishments to enter the sewers (see p. 241 for plumbing arrangements to control sewer gas).

Other Chemical Substances Present in Air.—Other chemical substances, *e.g.*, hydrogen sulphide and hydrochloric acid, sometimes exist in the air as vapors. While usually relatively unimportant, in manufacturing cities smoke or fog may hold such substances near the earth and make the atmosphere very irritating to mucous membranes. (Singers often complain if asked to include certain towns in their tours, and sometimes find a prolonged stay in such cities very injurious.) The chemicals mentioned and others, such as nitric and sulphuric acids, formed mainly by the burning of coal or in industrial processes, are usually found in small amounts (often less than 1 part to 10,000). These, as well as CO_2, are washed out of the air by rainwater or snow, finally reach the earth, and aid in certain of the soil changes (*e.g.*, disintegrating rock substances, forming mineral salts which are absorbed by roots). An attempt to emphasize the value of these processes is responsible for the expression, "Snow is the poor man's manure." Ammonia, formed in the decomposition of organic substances, is often produced

in noticeable amounts (*e.g.*, in stables). The amounts of such substances (*e.g.*, albuminoid ammonia) are sometimes used as a test of the organic impurities in the air.

Nitrogen.—No mention has been made of nitrogen, which comprises four-fifths of the air. Its great value is as a diluting substance. The injurious effect of ozone is due to its more rapid oxidizing powers; it is, therefore, an advantage to have oxygen diluted to 1/5 of its possible power by inert nitrogen. Neither increased oxidation in the tissues, nor increased combustion of fuels, is desirable for our bodies as things are now constituted on this earth. Nitrogen does not vary appreciably in inspired and expired air. It is found in solution in small amounts in the blood, though larger amounts are absorbed in caisson disease (G) (see p. 138).

Crowd Poisons.—Expired poisons, "crowd poisons," have been thought to explain the discomfort experienced in unventilated places, such as the Black Hole of Calcutta. Much experimental work has been done: causing animals to breathe expired air, and injecting washings of expired air into animals. Some of the early results have been interpreted as supporting the existence of expired poisons, but most of the work fails to prove the presence of such substances.

Odors.—We all know, however, that odors accumulate in occupied rooms. Odors often noticed in the breath (from decaying teeth, digestive disturbances), from the skin (surface substances: dirt, perspiration, and odoriferous glands), from the clothing (moist wool and fur), especially soiled underclothing, explain most of it. Certain excretory glands (*e.g.*, armpits) are more active and more odoriferous in certain individuals; certain races have characteristically strong odors. These may affect us unpleasantly, and though no direct effects have been ascribed to them, they are most undesirable for æsthetic and psychological reasons. Absolute body cleanliness is usually necessary to avoid such odors. A few individuals may find it advisable to reinforce this with some preparation for absorbing odors; but there is no excuse or reason for *covering* objectionable odors by perfumes and scented toilet powders. No one cares to be summed up in the phrase, "Perfume instead of soap."

Although the nose is usually an unreliable sanitary guide, some people seem to be sensitive to accumulations of expired CO_2, and

air containing twice the usual amount of CO_2 (0.06 per cent.) is described as "stuffy"; distinctly unpleasant odors may be noticed with higher amounts of CO_2. This effect has been related to the loss of appetite shown by subjects confined in experimental chambers. It may not be necessary to think of these accumulations as "affecting the nerves of taste" directly; such results may be due to slight and unrecognized forms of nausea, as nausea is, in some, a characteristic reaction to objectionable odors. (Habit, too, has long associated physical discomfort with decreased physical action and lessened food intake, and may explain decreased food intake in such experiments without recourse to special sense effects, as on the taste nerve endings.)

Dust in Air.—Dust particles increase the possible bacterial content of air, dust or lint acting as floaters or buoys for the bacteria. Dust itself may be very injurious, depending both upon the kind and upon the amount of dust in the air. Fibre or mineral dust, absorbed constantly or in large quantities, may cause irritation and even inflammation of the throat and lung membranes, causing chronic bronchitis or phthisis (see Industrial and Occupational diseases, Chapter XX, p. 316.) Some forms of dust (*e.g.*, carbon) favor the formation of fog and tend to keep a definite fog or "chemical pall" over manufacturing and mining towns. Such fog and smoke are definitely irritating to respiratory membranes, and by such irritation may predispose to respiratory diseases, as they decrease the window ventilation of the overneat housewife, and decrease the actual amount of sunlight that can penetrate the atmosphere. Modern methods of cleaning (vacuum cleaners, moist dustcloths) are now preferred by all intelligent housewives. Street dust is, however, responsible for much of our house dust; smoke from chimneys, dust from ash cans and carts, grit ground off the paving stones and asphalt, and dust from the roads, are constantly finding their way houseward (*e.g.*, on clothing, through windows). Oiled streets and other methods of reducing the street dust would simplify greatly the housekeeper's problems.

Relation of Atmosphere to Light and Heat.—The effects of the atmosphere, though unrealized by us, are, nevertheless, most important; and though usually beyond our control, it is interesting to know what they are. The air itself (water vapor also, and more markedly, dust particles) limits the penetration of the sun's

light and heat. Our colored sunsets, the morning glow, and even the blue of the sky, are illustrations [2] of this.

More important from a hygienic standpoint are the following effects of this limitation of the penetrating powers of light and heat. It makes our daylight less brilliant and less unbearable in midsummer; the bactericidal effect of sunlight is reduced; our heated periods (days, summers) are less intensely hot, and we receive correspondingly less heat in winter. But while the atmosphere keeps some heat out, it also tends to lessen the rate at which the earth radiates heat, thus "holding the heat in." Our earth temperatures are more uniform; the nights are not so cool as they would be had we no atmosphere, and the winters are also less cold because of this retained heat.

Atmospheric Pressure.—We are wholly unconscious of the weight of the atmosphere, even though it exerts a pressure of fifteen pounds upon every square inch of our body. Though the body tissues are attuned to this, we can vary this pressure considerably by going deep down into mine shafts or to the tops of high mountains without being conscious of any change in pressure. Great extremes, however, cannot be met easily and man can stay but a short time at great depths; animals brought from the depths of the ocean cannot live at sea level. This is partly due to the inability of the tissues to meet the new pressure conditions. Such inequalities in pressure may be illustrated by the ear pains noticed by many people in passing through under-river tunnels, when, in trains, one passes so quickly to a depth with greater pressure that the air in the inner ear remains rarer than the air pressing against the ear drum from the outside. The drum is pushed in and we

[2] Ordinary white light can be broken up into seven prismatic colors: violet, indigo, blue, green, yellow, orange, and red. The red rays are stronger than the orange rays, the orange, than the yellow, and so on to the weak blue and violet rays. Under ordinary conditions, more of the stronger (*e.g.*, red and yellow) rays get through the fifty or more miles of air enveloping our earth. Therefore, ordinary sunlight is more yellow than white. The weaker blue rays are so held back by the air envelope that as we look up far into its depths, we see those blue rays as a blue sky. The sunset and even sunrises seen over dusty cities are usually brilliant, orange, gold, or red predominating, for only the stronger rays get through the dust-filled air to us. After volcanic outbursts red skies or sunsets (due to the fine dust) may be noted often for months, and even on distant continents. See "Nature For Its Own Sake," by John Van Dyke, if interested in this side of air and light.

become conscious of "fullness" or pain. Swallowing, or even talking, may prevent one from feeling this phenomenon, for then the denser tunnel air passes through the mouth and the Eustachian tube into the ear; pain ceases where there is no longer any *difference* in pressure on the two sides of the ear drum.

Effects of Pressure on Gases in Blood.—The effects commonly discussed under pressure are, however, of another type. They are due to the fact that gases are held in solution in amounts varying with atmospheric pressure. (Different gases have, of course, different initial rates of solubility, *e.g.*, carbon dioxide is more soluble in water than oxygen, and oxygen more soluble than nitrogen.)

Therefore the amounts of oxygen, carbon dioxide, and even nitrogen in solution in the body liquids (lymph and blood) vary with the altitude. The adjustments necessary to meet any increase or decrease in oxygen, for example, are made so promptly and so mechanically that we are often wholly unconscious that respiration and circulation have been modified at all. At great heights the air is very rarefied and the pressure is much less. The amount of oxygen held in the blood is reduced. In other words, a given amount of blood cannot then carry or hold its usual amount of oxygen. If the *tissues* are to have their usual amount of oxygen, more blood must be sent through those tissues in a given time; therefore, the blood must circulate more rapidly. A quickened circulation and increased respiration (depth or rate or both) are the main compensatory changes noticed at high altitudes. (There are other changes; *e.g.*, the increased evaporation of water from the skin means lessened kidney excretion, and the heat loss due to this increased skin evaporation may call forth the compensatory changes already discussed under temperature.) Unless these changes fully compensate for the decreased gas tensions in the blood (its lessened power to hold oxygen and also carbon dioxide in solution), the tissues will receive less oxygen from the blood, and the blood will takes less CO_2 from the tissues. Drowsiness and finally unconsciousness are common results shown at high altitudes. The compensatory work demanded by the altitude may exceed the power of the respiratory and circulatory systems. The condition of the lungs and heart is, therefore, an important part of the physical examination required of army aviators. The highest altitudes at which con-

tinued residence is known is 5880 metres (or 19,290 feet); at this height the atmospheric pressure is but less than half of the pressure at sea level. Temporary altitudes of 7925 metres (or 26,000 feet) and probably 9000 metres (or 29,550 feet) have been recorded for aviators. Some idea of the body adjustments required by such altitudes may be gained from the following figures:

Altitude	Pressure (mercury) barometer	Oxygen pressure	Per cent. Oxygen
0 or sea level..	760 mm.	100 per cent. (or normal)	20. per cent.
8050 meters ..	251 mm.	52 per cent.	6.8 per cent.

It has been claimed that compensation for reduced oxygen pressure is made by increasing the number of red corpuscles. The increases described have apparently been more rapid than their method of formation would allow. A slight increase in the number of red corpuscles in a given bulk of blood may be found, because the evaporation of water from the body is more rapid at high altitudes, and there would be a slight decrease in the total bulk of the blood in the body and a slight increase in the concentration of the blood. But it is thought that the claimed increase in the number of corpuscles is mainly explained by the difficulties attending the making of the blood counts (G) at high altitudes. The samples of blood, exposed to the air during this process, lose water very rapidly, and the unit placed on the slide for counting is, therefore, a concentrated liquid yielding a higher red corpuscle count.

Increased Pressure.—Below sea level, the pressure increases rapidly. Ten metres (thirty-three feet) means twice the pressure; thirty metres (about one hundred feet) below sea level the pressure is increased four times, and equals sixty pounds per square inch. There is an *increase* in the gases held by the blood, and even nitrogen may be absorbed by the blood in appreciable amounts. The results of greatly increased pressure are, as would be expected, the opposite of those experienced with decreased pressure at high altitudes. The respiration and the circulation are slowed; the evaporation of water is decreased; headache, dizziness, and acute pain may be experienced until the pressure inside the body becomes equal to the outside pressure. Deep sea divers were formerly our common illustration, but the present method of building under-river tunnels by increasing the air pressure in a given structure or caisson sufficiently to keep water and mud out is more familiar to most of us.

The atmospheric pressure in such cases is rarely more than four times the sea level pressure (sixty pounds per square inch). A return to normal pressure is often accompanied or followed by intense suffering (pain, paralysis, etc., called "bends," "caisson disease"). The gases diminish in amount in the body liquids as the lower (normal) pressures are reached; and often form "gas emboli" or bubbles, especially when the change from great pressure to normal pressure is made too rapidly. Oxygen and carbon dioxide are more easily absorbed by the blood; that is one reason why emboli are less often due to them than to nitrogen. These gas bubbles or emboli may interfere with the circulation by clogging a capillary or rupturing the capillaries, causing serious internal hemorrhages; or death may follow from the pressure exerted by these bubbles in dangerous areas, such as the brain and spinal cord.

Ventilation.—Ventilation—a word of varied meanings—usually implies a replacement of used air by fresh unused air. *Always* would seem the natural word to use here instead of *usually,* except that, recently, used air has been washed and used over again. The replacement of used air (whether constant or periodic) must be rapid enough to prevent the accumulation of odors, heat, humidity, factory dust, etc., in objectionable amounts. *Adequate* replacement is usually implied in the term; for example, we speak of certain rooms as being poorly ventilated when the air replacement is so slow that we become conscious of the accumulated odors, moisture, etc.

Ventilation is a cold-weather problem, and when we speak of a good ventilating system, or of a room or building as well-ventilated, we mean more than an adequate replacement of air—bulk for bulk. We mean that the fresh air is supplied without noticeable drafts and without periods of unpleasantly low temperature. Where the subtraction of used air and the addition of fresh air are made gradually in small amounts, these difficulties are less often met. When the fresh air is taken directly from outdoors, both may be noticed, unless the fresh air enters through specially contrived openings (1) directing the entering air away from the occupants of the room or (2) forcing it through finely meshed screens. Cold outer air is often heated by radiators placed directly under the windows, thus avoiding chilly drafts. Used air becomes both warmer and moister (lighter); therefore, vents for used air are often placed

near the top of the room, often opening into the chimney, the draft in the chimney favoring the upward passage of the heated used air. There are advantages, however, in having the heated air come in near the upper part of the room, as shown by the following illustrations, showing how much more completely the fresh air diffuses through the room (Figs. 33 and 34). By pumps, fans, etc., other methods of intake and outgo may be used, and the used air may often be drawn out at the bottom of the room. Special ducts for

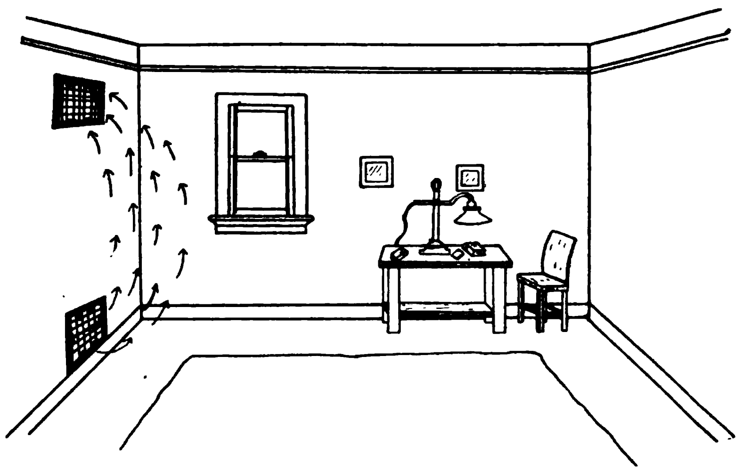

FIG. 33.—Formerly it was more common in special heating systems to have the warm air come in at the bottom. In such systems why is it not advisable to take the used air out of the same side of the room?

air intake and outgo are found in systems which are thrown out of operation by *other* openings or currents, and in which the windows must, therefore, be kept closed. (This makes these systems unpopular with most people: the psychological effect of an open window is well known, whether the individual desires it open or whether he desires it shut.) The result is that irregular or too high temperatures and changing conditions in the occupants of the school or factory (greater muscular activity or excitement) make the closed windows seem unbearable at times, and here and there windows are opened, giving relief in the rooms concerned, but throwing the system entirely out of operation for other rooms. These various

systems are so different in details, and so few students taking only elementary courses in hygiene will be called upon to operate or install complicated ventilation systems that they cannot be given more space here. If such responsibility comes to any individual, he should consult more advanced texts, studying the matter thoroughly before making such a momentous decision—for a system once installed is very difficult to change, and the cost, which is often enormous, sometimes bears little relation to the value of the

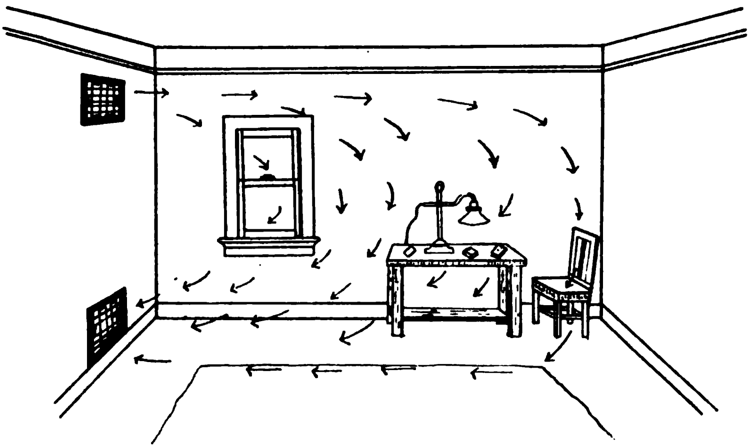

FIG. 34.—If fresh heated air enters near the top, it diffuses more gradually through the room as it cools, as shown by the above illustration. (There are good systems in which the inlets and outlets are arranged very differently, however.)

system. An indication of these difficulties is shown by the fact that some systems are built upon erroneous statements regarding the weight of moist air, or the relative amounts of water in warm and cold air.

While it is desirable that the incoming air should not be admitted at such low temperatures or at such long intervals, and therefore in such large amounts, that it produces a noticeable chill, there may be a distinct disadvantage in the accurately controlled thermostat heating. If it is too perfectly regulated, the temperature is too uniform, and the skin loses the opportunities for constant exercise as a thermal regulator. That is one advantage of leaving the windows as part of the ventilating system; short, sharp changes in

temperature may have a decidedly tonic effect upon the physical and mental condition of the occupants, especially when they are under control of other people, occupied with monotonous work, etc. Recent studies of several thousand school children showed fewer absences due to any illness, and fewer cases of respiratory diseases in the children occupying window-ventilated rooms than for children occupying rooms mechanically ventilated (p. 261).

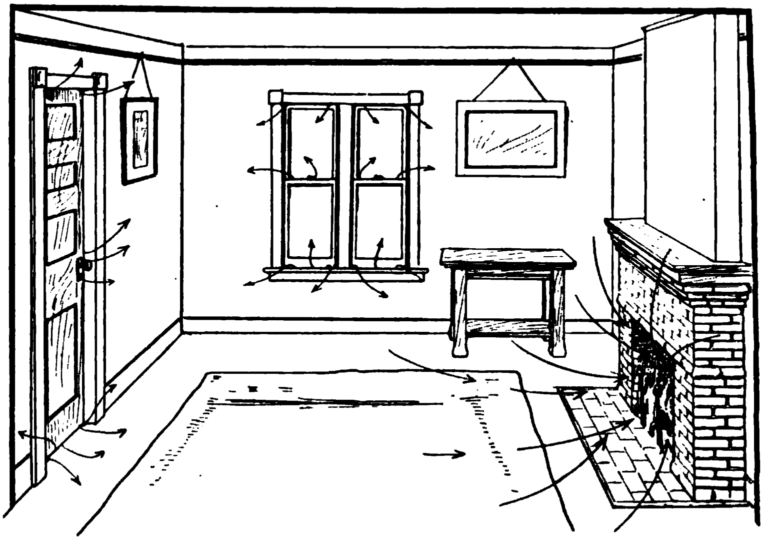

FIG. 35.—This indicates how much cracks and fireplace help in ventilation.

Natural Ventilation.—Many of us know homes and other buildings where ventilation is a matter of little concern, and yet the air is not noticeably bad, and the occupants are apparently not affected by such carelessness. Fortunately, a considerable exchange of indoor air and outdoor air is accompanied by the opening of doors as the various members of the family go about their customary work or play. The restless child, who "won't stay in or out," often performs a real service for the home. Most buildings have enough cracks and openings to afford a constant, though often inadequate, replacement of the indoor air (Fig. 35); these include fireplaces, loose window sashes, sagging doors, and unputtied window frames.

Storm doors, double windows, felt or metal weather-strips delay this replacement, but are popular because they conserve the heat. If the heating system allows any margin, and these openings do not cause objectionable drafts, it is better to omit such common preparations for winter, unless sufficient ventilation is provided for otherwise (air ducts, daily open-window airing of rooms, etc.).

Air exchange is also accomplished *through* the building materials themselves. A strong wind may force large amounts of air through brick, stone and hollow tile walls. This "spontaneous ventilation" may mean an interchange of several cubic feet per hour for every square yard of surface. This means loss of indoor heat, so we make our walls poorer conductors of heat and less favorable to air exchanges by better insulated or more numerous air spaces; *e.g.*, by air spaces between the lath, layers of tar or sheathing paper between the framework and the shingles, and paint or paper on the inside walls.

The exchange described in the last two paragraphs may be sufficient to prevent discomfort due to the accumulation of gas, moisture and heat. They do not always prevent the accumulation of odors, and a definite effort to secure good aëration is usually necessary to avoid "stuffiness."

Indoor air is usually too dry. It probably always holds as much water per cubic foot as the outdoor air, and usually holds much more. But it *can* hold so much more at the higher indoor temperatures that it is often relatively very dry (as explained under humidity). What it can yet take up is what really affects us by affecting the rate of evaporation of water from our body and the resultant loss of body heat. In winter it is, therefore, not enough to add warm, fresh air; moisture must be added, also. If rooms at 20° to 21° C. (68° to 70° F.) are not warm enough, it is because the air is too dry, and the resultant evaporation gives the sensation of "chill" which makes us demand more heat, when we might more economically secure comfort by adding moisture only. To most people the estimates of the water necessary to provide the required humidity will be startlingly high. One authority estimates that hot water boxes should add 15 gallons per day to the air of an ordinary house (17,000 cubic feet); another kept a favorable humidity by evaporating 4½ gallons per day in his office; one square foot of

water surface per ordinary house room (10 × 14 feet) is a third estimate; and the Bell Telephone Company in Boston evaporates 1½ barrels of water per hour for a building containing 450 employees, thereby requiring "3° less heat for the maintenance of an agreeable temperature." Well-ventilated rooms, therefore, not only have the used air replaced by fresh air, but by fresh air of suitable heat and water content. The value of moisture is not realized by most people; their only concern seems to be that the glued "furniture cracks apart—steam (or furnace) heat is so drying, you know."

Washed Air.—In institutions, office buildings, etc., these needs have led to the installation of special "systems" of heating such as washed air, whereby sufficient renewals of warm air of suitable humidity may be supplied, without waste in that expensive requisite, heat.

It can be readily seen that there is great economic waste in continually heating and discarding thousands of cubic feet per person every day. Washed air, which can be returned to the room without loss of heat, has therefore been advocated. The used air is washed by a spray of water or is forced through a reservoir of water, and odors, most gases, dust, etc., are removed. CO_2 is not removed, but good results, judged by physical and chemical tests and by mental tests of the room occupants, indicate that washed air has real value. Some authorities claim that odors, too, are not fully removed.

Rate of Air Renewal.—The estimates of air needs were formerly based on the CO_2 accumulation, though now we know that temperature, humidity, air movement, and foreign substances (dust, bacteria, etc.) are much more important considerations. Most people still accept 2000 to 3000 cubic feet per hour as the average need for each individual. In small rooms, where the actual room space is less than this minimum, the same result is secured by replacing the air more rapidly. The estimate varies with the size of the individual, the amount of work or exercise, and what is not often realized, the shape of the room. A room with high ceilings may enclose a large amount of air, but if a great part of that air lies above any wall opening (*e.g.*, window, ventilator), it is really a dead air space in which the air is affected very slightly by most ventilating schemes. Most of us know that such ceiling air is

warmer, but we fail to recognize that other products of vitiated air (*e.g.*, odors, gases, moisture) diffuse so slowly that the upper layer of air is little affected by the fresh air below. This leads some authorities to emphasize the *square* feet of *floor* space rather than the *cubic* feet of *air* space. Cases of fainting in outdoor crowds are not uncommon in warm weather; in such instances the body accumulations (heat, moisture, odors) did not diffuse through the air—even upward—rapidly enough to prevent discomfort. Floor space requirements range from 10 to 50 square feet per person, varying with the *cubic* feet of air space also obtainable for each.

Cooling Systems.—Hospitals and office buildings have been the pioneers in installing cooling systems for summer. "Comfort" is a sufficient excuse, but how much comfort adds to the working power of an individual or to the life chances of a sick baby, few of us realize.

Schemes have been advanced for conserving summer heat for winter heating, and for storing chilled air or water in the winter for summer use, but few institutions or individuals have actually installed cooling plants, though some advantage is taken of the benefits derived from air movement (electric fans) and, less often, from water evaporation (as described earlier in this chapter). When health is really recognized as the *one great asset* of the individual and the nation, and when the relation of physical comfort and efficiency is firmly established, we may expect to find all civic and commercial institutions fitted with cooling plants for summer, as well as heating plants for winter. Really efficient heating systems are less than eighty to ninety years old, and the refrigerating systems have been so perfected that we may confidently expect some relief from the intense summer heat within the next generation.

Although complicated systems of ventilation do not belong in an elementary book of hygiene, there are many simple aids to ventilation that every one should know about; for most of us control entirely the ventilation of one or more rooms, especially at night. Two windows, especially if not on the same side of the room, flush a room much more rapidly than one window, even when the open area is the same. With one window, openings at the top and bottom are more effective than but one opening at the top or bottom; even with two openings cold air may enter the bottom and go directly

out at the top, affecting very slightly most of the room air. A board inserted below the lower sash raises the top of that sash sufficiently to let in small amounts of fresh air constantly. Instead of a board, screens with slanting (glass) shields are sometimes used; these give two openings instead of one, and by throwing the screened air upward, make drafts less noticeable.

Sleeping Porches.—Sleeping porches have two advantages: (1) They conserve heat otherwise lost by opening the windows at

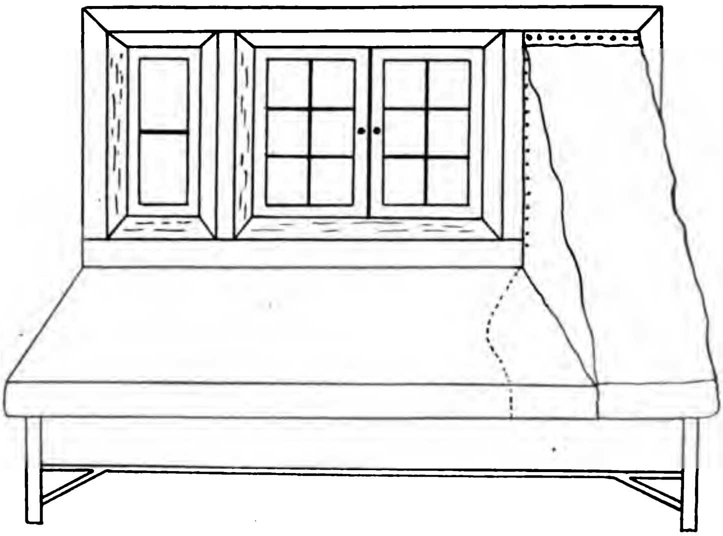

Fig. 36.—A sleeping hood fastened over a window screen and fitted into a casement window which opens out; this hood is folded under the mattress at the head of the bed and runs down between the lower and top blankets.

night, and (2) they insure good fresh air for eight or ten hours of the twenty-four. If the sleeper buries his face beneath the bedclothes, even outdoor sleeping does not insure unvitiated air, for the bent neck or layers of blankets cause him to re-breathe the same old air. That animals (cats, dogs) do so habitually or that hibernating animals do so for long periods (respiration very slowed, however), or that foreign nations have slept for years in closed box beds or under feather beds, should not be considered an argument against fresh air. As strong, on the other side, is the discomfort

felt by fresh-air people when compelled to breathe vitiated air. And we have all experienced the lassitude, headache, loss of appetite due to close and stuffy places (Pullman coaches, unventilated rooms). A still greater warning is the anæmic condition of those who habitually "shut themselves up." That air conditions have much to do with this is indicated by the higher death rate of soldiers in crowded barracks than in less crowded ones, even in regiments where all were selected by the same general health standards, and all had the same food, exercises, etc. The beneficial results directly traced to open-air schools, open-window schools, and open camps for the tubercular show that fresh air offers indisputable advantages for all of us. Unless one can command sufficient bedding or can afford the greater loss of energy represented in the greater amount of heat given off in surroundings colder than the ordinary bedroom, including the initial amount required to warm a thoroughly chilled bed, it would be wiser to sleep indoors. Any ingenious person can "rig up" a hood of canvas, old blankets, etc., which can be fastened to an extra glassless sash (or tacked permanently around the lower half of the window). This can be tucked over and around the pillow and under the mattress, allowing plenty of fresh air around the head, while the body remains in a warm room, which is comfortable for both the evening and morning toilets (Fig. 36). Of course, each must carefully decide for himself whether outdoor sleeping is really unwise; too often a sluggish skin or mere inertia is allowed to settle the matter.

PROBLEMS

1. How does fresh air enter your schoolroom in winter time? How often would the air have to be replaced to give each person the minimum requirement, 2000 cubic feet per hour?

2. Explain why increased humidity makes hot days hotter and cold days colder.

3. Explain the system of ventilation in this building. Does it contradict any of the accepted laws of physics (*e.g.*, hot air rises)? In a large institution the janitor might be asked to describe the system to the class. What are the advantages to be gained (for the student and for the school) by so doing?

4. How could the ventilation of this room be improved without changing the system of heating or ventilation already installed?

5. How much air space per person in this schoolroom? In the school assembly room? How long should students sit there without opening the windows or otherwise replacing the air?

6. What effect do winds have upon the air of this room? Describe a room in which they would have greater (or less) effect, and explain why.

7. Collect all the facts you can in favor of frequent exposure to outdoor air; errands outdoors, short walks to school or business, sleeping outdoors, or outdoor schools, etc.

8. Does the amount of water evaporated daily in your room (house) during the winter indicate that the humidity is sufficiently high? Does the temperature found necessary for comfort support this? Can you secure a wet-bulb thermometer to test this?

9. Design a sleeping hood to fit in the lower part of an ordinary sash window and to cover the head of your bed. Construct it upon a fly screen or framework just the size of the lower sash, so that it will fit snugly (as screens do) into the space made by raising the lower sash. How can you prevent drafts or loss of heat around the outside edges of the hood? (A little cape or a small blanket which can be cut half way across and then fastened around the neck makes a desirable addition to this sleeping arrangement.)

10. Without winds sandstone and brick surfaces may pass four to eight cubic feet of air per hour in a square yard of surface; and winds increase this amount many times. How would this affect the heating of rooms with outside surfaces? Their ventilation?

11. During a storm 200 steerage passengers on the steamer Londonderry were shut below over night in a space 18 feet by 17 by 11, without any ventilation at all. In the morning over seventy were dead. What caused their death?

12. An ordinary fireplace fire means a movement of 18,000 cubic feet per hour. How is this amount of fresh air supplied to the fire in your house? At the minimum rate of 2000 cubic feet per person per hour, will this supply the necessary ventilation for your living room?

13. A fireplace fire demands 2600 cubic feet of moving air per pound of coal used. If you used fireplace heat and ventilation only in your room, what would adequate heat and fresh air cost you per day?

14. The minimal room space is one-third of the required cubic feet of air necessary per hour, but hospitals count on full space for ordinary patients and 2500 for fever patients. Explain why this is advisable.

15. Show why an opening into the chimney near the ceiling is usually a good place for the outgoing air vent.

See Reference List at end of Appendix.

CHAPTER VII

SEWAGE DISPOSAL

DESPITE the great complexity of the problem of sewage disposal, there are, after all, but two ways of disposing of sewage: the dry-earth system and the water-carriage system.

The Dry-earth System.—In this method of sewage disposal dry earth is used to cover the contents. This may be done by a mechanically adjusted hopper, which automatically showers earth into the vault below, or, more simply, by adding shovelfuls of earth from a bucket or box kept in the closet. The disadvantages of this method are that it necessitates keeping on hand, protected from rain and freezing, a large amount of earth, ashes, etc., suitable for this purpose; filling the hopper or bucket with fresh earth or ashes is a daily chore at least, and must be attended to in all kinds of weather; because of these earth additions the bulk in the receiving vault increases rapidly, necessitating frequent emptying of the accumulations.

The ordinary privy should be turned into a dry-earth system. Even then, flies will be attracted to such places, and seat covers that automatically close when not in use should be provided (Fig. 37), and the vault should be of tight construction or completely screened to prevent the entrance of rats and flies.

The Pail System.—The pail closet has little to recommend it if other methods are possible. The pail should be removed at least daily and the contents buried. This makes the pail closet really a dry-earth method. The pail closet has all the disadvantages of the dry-earth closet plus the disadvantage of splashing and the more unpleasant task of emptying and properly cleaning the pail. Splashers in or above the containers are impossible to keep clean, though the slight fall in such closets makes such a device desirable. The person upon whom the task of emptying and cleaning the containers is forced is usually more concerned in doing it the quickest way than in doing it the right way. Burial demands a larger area for receiving such material than is usually obtainable. Pail-closets should not be constructed unless care can be assured.

Wherever possible, the dry-earth methods should be supplanted by water-carriage systems. Warren has studied this question from the point of view of land valuations in the city and country, the real

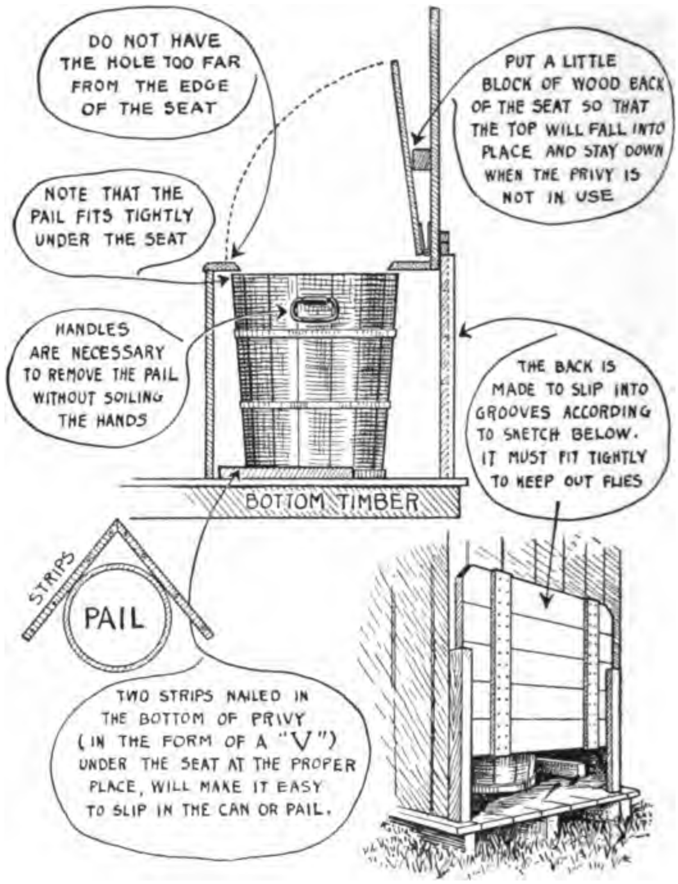

FIG. 37.—Pail and seat details of a sanitary pail closet.

cost to the cities (assessments, indirect taxes, etc.), and decides that the cheaper construction possible in the country makes water-carried plumbing just as possible for the rural districts as for the towns and cities.

Introduction of Water-Carriage Systems.—The water-carriage system is relatively new. Harrington pictures a curious water-flushed closet in use in England in 1596, but water-flushed closets did not come into common use until a relatively short time ago. Until recently it was forbidden to empty any house drainage into the sewers. London did not allow it before 1815; Boston, 1833; and Paris not until 1880. Once introduced, water closets rapidly supplanted more primitive devices. London, in 1847, required water closets to be connected with the sewers; Chicago began a water-carriage system in 1855, and Boston in 1875. Many of our cities were much slower; Baltimore is only just completing a complete sewerage system.

Processes Important in Sewage Disposal.—Water-carriage methods always seem very complicated to beginners. This is partly because there *are* so many different methods or modifications, and partly because it is not always made clear that all these different methods are but different ways of securing one or both of the two chemical changes desired: (1) oxidation or (2) putrefaction; each of these processes causes the decomposition of organic matter, changing it as completely as possible to *in*organic substances. The whole process might be summed up as a "mineralizing of the organic wastes." Some systems do this very rapidly and very completely; in some systems this is but partly accomplished before the sewage is discharged; when the sewage is discharged directly (*e.g.*, from a vessel into the ocean) no such changes take place before discharge, but these changes take place in the ocean itself.

Disposal Without Previous Treatment.—As Rosenau says: "The basic principle that underlies all methods of sewage disposal is to get rid of the sewage as speedily as possible, with the least nuisance to the smallest number of people, with the least damage to health or property, and at the smallest cost." All these considerations vary with the relative deneseness of the population, the chance of polluting the drinking water, the possibility of using the ocean instead of inhabited land areas for sewage discharge, etc. All this means that often we must hold back the sewage until mineralization has partly or even completely taken place. In such cases most complicated systems of "purification" may be used.

The simplest classification of these water-carriage systems might be on the basis of the *place* to which the sewage is carried—the land

or the water. Discharge into the ocean is a very simple matter, if the discharge pipe is below low tide level so that recurring tides do not carry back such discharges. It is equally important to see that all community interests are left uninjured: bathing beaches and oyster beds must not be polluted; sometimes currents, eddies, etc., may carry such material quite directly to houses or towns some distance away.

River-discharge is less satisfactory, especially if the streams are small, or if towns down stream are too close to allow the sewage to be diluted with a margin of safety before they take out their drinking water, use it for bathing, etc. Sewage-polluted rivers have another disadvantage. The large amounts of oxygen necessary to oxidize the organic sewage may take oxygen from the water more rapidly than it can be absorbed from the air above the water, and fish cannot live in this oxygen-poor water. Shad fishers in the lower Hudson are complaining bitterly over the difference between the catches possible now and twenty years ago. The heavy pollution of the river water by the sewage of 175 towns and municipalities, including New York, is a large factor in causing this relative scarcity.

Lake conditions are much like those described for rivers and for the ocean. The smaller size and the lack of current in many lakes make more care necessary regarding the amount of sewage and the distance of the discharge pipe from the shore line. If large amounts are discharged, it may be necessary to extend the pipe several hundred feet out into the lake.

Methods of Treatment Before Disposal.—When sewage is emptied directly into the water, the bulk of the water with which it mixes may be large enough to prevent the sewage from being a serious menace. In time many of its original bacteria die off (see p. 104), any pathogenic ones it originally contained disappearing quite rapidly, usually. The "Chicago canal" is a huge sewer which carries Chicago sewage via the Illinois River to the Mississippi; the natural agents have by that time so affected the sewage that it causes no nuisance to towns near its entrance into the Mississippi about three hundred and fifty miles from Chicago.

In most cases, it is better, however, to treat this sewage in such a way that it will not be dangerous nor even objectionable (*e.g.*, odors) before it is discharged, especially if it is discharged on land

instead of into water. The large volume to be handled makes some reduction in bulk necessary, for the sewage to be disposed of averages daily 50 to 200 gallons per person. This reduction in bulk is secured by screening, sedimentation, etc.

Screening.—The simplest method of treatment is screening. Wire screens of very fine mesh are often used to hold back the coarser materials, and the finely suspended matter and all the liquid part pass through.

Sedimentation.—Another simple way is to let the sewage stand in some kind of receiving tank while the solids settle. Since sewage is mostly water (less than 1 per cent. solids), this means that with complete sedimentation relatively little bulk would thus be left to care for.

Chemical Precipitation.—Such sedimentation is too slow a process, however, and the sedimentation is often hastened by adding a chemical to the water. Sewage may average 100 to 200 gallons per day per person; cheap chemicals must therefore be used. The commonest ones are lime and iron or alum salts. These help precipitate the solid particles and even part of the material in solution; they also remove one-half to two-thirds of the organic matter, and lessen public nuisances (odor, etc.) connected with the liquid discharged. Screened, sedimented or chemically-precipitated sewage is much easier to dispose of, for the liquids can be allowed to run into the nearby waters without so much danger of clogging the harbor or filling the river channel. The relatively small amount of solid material or sludge can be more easily disposed of: buried, spread out upon the ground, or, as is done in London, put upon scows, and dumped far out at sea.

These methods do not make the sewage safe. They simply make it easier to dispose of the bulk found in most cities. Even the reduced bulk obtained by sedimentation, precipitation, etc., may be difficult to manage, it may amount to 100 to 200 barrels per day in towns of only 5000 people. Sewage disposal is a bigger problem than merely separating out this sediment or sludge.

Sewage Farms or Broad Irrigation.—It is well known that on ordinary soil one may discharge a fair amount of liquid wastes without any noticeably disagreeable results, *e.g.*, dish-water. If the soil is open or sandy, large amounts can be taken care of without creating any objectionable condition. But if too much is discharged

upon it, the soil becomes water-soaked, wet and sour. In inland cities without water connection, there is a limit to the amount of sludge that can be taken care of on the limited area available near large cities or towns. Because of the organic matter in sewage, it was thought that it would furnish valuable food material for plants. Enthusiasts forgot to take into consideration the low percentage of total solids in sewage. Irrigation farms were started, some of them on a gigantic scale. A recent report indicates those in Berlin are now being discarded. The soil in all cases finally becomes clogged with the finer particles in the sewage and oversoaked with water. The cultivation of water-loving plants, or plants with much leaf surface (for leaves give off large amounts of water), has not helped materially in reducing these conditions. When sewage or sludge is exposed in this way, there is always some danger that pathogenic organisms may still be alive and do harm. It is not wise to grow vegetables which are eaten raw (*e.g.*, lettuce, radishes) on such sewage-farm land, for typhoid organisms have been found on plants grown in soil manured by human excreta.

Subsurface Drainage.—This last danger is avoided when the sewage is deposited *under* the surface of the ground. The sewage runs along a branching route in loosely constructed stone-walled ditches or drains made of hollow tiles or pipes (Fig. 38). These pipes are laid with their joints slightly separated, so that while most of the sewage passes on despite the loose joints, a little leaks through at each joint. This is absorbed into the surrounding soil, and finally decomposed by the bacteria present there. If two systems of such drains are constructed and used alternately, the soil has a chance to "rest"—to take in more oxygen from the air and so do its work more effectively. Figure 38 shows diverting manholes to accomplish this purpose. For subsurface drainage gardens and cultivated fields may be used; the manurial value of sewage is not entirely lost in this method.

Filters.—If sewage deposited in or on the soil can be cared for as described—if manured and other surface-polluted waters can pass into the soil and come out in wells or springs clear and quite free from bacteria—there is no reason why this filtering action cannot be utilized to purify sewage. Huge beds of sand with drains or coarser material at the bottom are used as sewage filters (Frontispiece). These huge filters receive crude or untreated sewage on

their surface, but the liquid trickling through at the bottom is clear, odorless, and quite free from bacteria. People sometimes

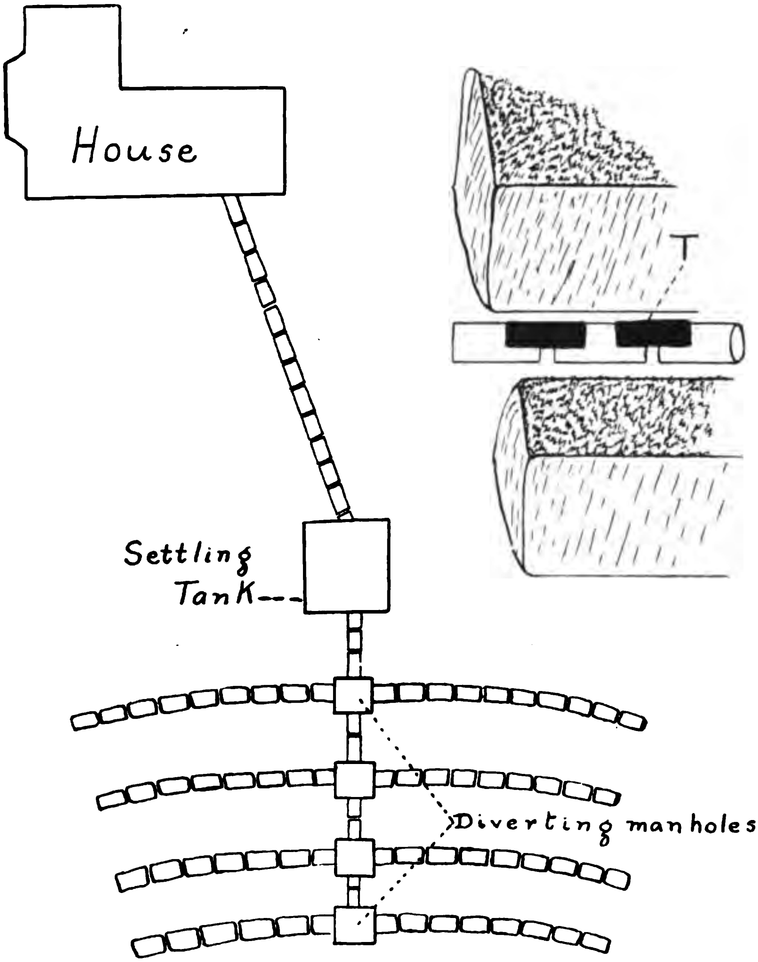

FIG. 38.—Subsurface drainage scheme with a detail on the right showing sunken tiles, placed slightly apart, with covering strips of tar paper, T, to limit somewhat the upward distribution of the escaping sewage. What advantage is gained by having a settling tank? Diverting manholes allow alternation of the areas used.

drink it fresh from such filters (without any other treatment) just to prove how effective the filters are.

Such filters are not exactly filters, despite their name. The action seemed like that at first, and the name is now firmly fixed. That filtering is not the process is shown by the fact that tight, fine sand filters do not work so well as loose, porous ones. If the process is allowed to go on slowly, the effluent which passes through is much clearer than when the passage is rapid. This shows it is not merely a retention or filtering process. We are forced, therefore, to consider the filter mainly a place where oxidizing bacteria come into contact with the organic substances in the sewage and decompose them. Since they act by oxidation, air is necessary. The coarse structure at the bottom allows the entrance of air. Coarse sand has more of these air spaces all through the filter than fine sand has. On all the surfaces of the sand, stones, etc., these oxidizing bacteria adhere, making a general covering which comes into close contact with the sewage passing through.

Intermittent Filters.—Complete aëration of these filters is best secured by allowing them to remain unused for a period. In practice, therefore, such sewage filters are always intermittent filters. Then, as in the resting periods advised for subsurface drainage, fresh air passes into these spaces, thus providing more oxygen for the oxidation processes necessary to take care of the next lot of sewage.

Trickling Filters.—There are other ways of securing sufficient oxygen for the work of these oxidizing bacteria. Instead of stopping the flow and losing hours of service daily, one might mix air with the sewage as it passes into the filter. We therefore find various schemes for mixing air and sewage. The most effective is to empty the sewage upon the bed or filter by a series of pipes from numerous openings in which the sewage spurts up in sprays or fountains, falling down well mixed with air upon the coarse stones on the upper surface of the filter. This filter is much more porous than the other filters. (See frontispiece.)

Activated Sludge Tanks.—A recent but very promising way of mixing the air with the sewage is simply to collect the sewage into tanks and pump in compressed air at the bottom of the tanks. Large amounts of air can be forced through the sewage and very rapid oxidation takes place. Small particles of suspended matter in the sewage become covered with a slimy bacterial coating, and these are kept in constant movement through the sewage by the

rising bubbles of air. When the liquid is allowed to run off, some of the sludge is kept in the tank. This consists mainly of the bacteria-coated particles, which "activate" the new lot of sewage.

Septic or Hydrolytic Tanks.—In all of the water-carriage methods described above, the bacterial action depended upon the

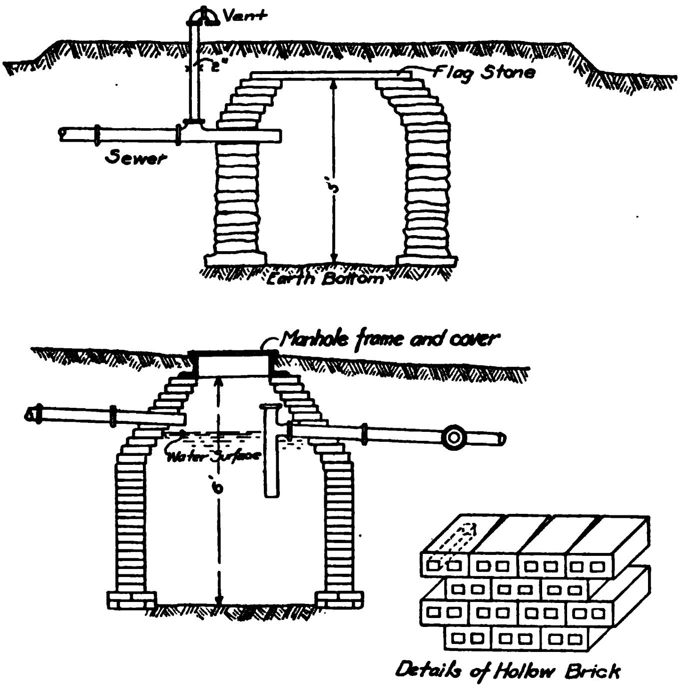

FIG. 39.—Two cesspools—one made of loose stone, the lower one of hollow brick or tiles; both allow "leaching" of the contents through the side walls and through the earth bottom. The extension on the right of the lower one is made of tile, much as in Fig. 38. Cesspools that overflow have been made satisfactory by such tile extensions.

presence of oxygen. As stated earlier, there is another important bacterial process, *putrefaction,* which may aid in breaking down of sewage. These bacteria do not do so well in well-aërated places, such as trickling filters. Their activity is, therefore, greatest in the deeper levels of the sewage tanks.

If sewage is allowed to stand in a tank, the grease tends to rise

to the top. This, if undisturbed by later additions, forms a film across the top. Beneath this the oxygen-using bacteria may operate for a while, but soon the oxygen is used up and the bacterial action is of the other type, the putrefying type, which, due to the organisms, do not need free oxygen for their work. In time these bacteria may decompose or break down the sewage so as to leave very little solids or sediment in the tank. To such tanks is applied the name "septic tanks." Special septic tanks have been constructed to secure more complete digestion of the sewage; in these, sewage is re-

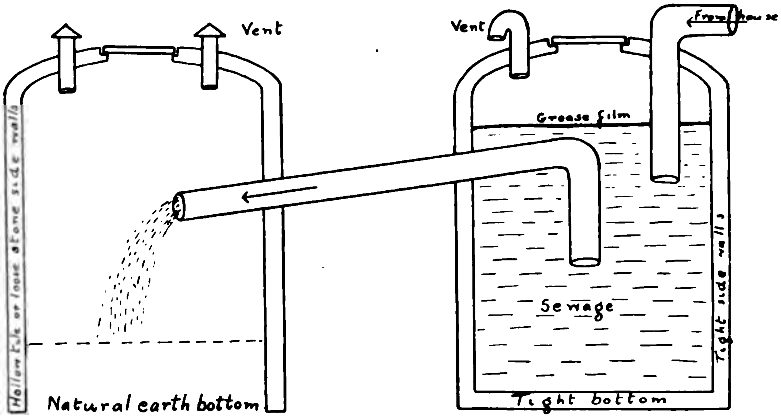

FIG. 40.—Drawing of a double cesspool which has not been cleaned in over 12 years, though receiving all house waste of two families (or a total of seven people). What is the difference in the bacterial action in these two cesspools?

tained for varying periods of time—several hours to one or even two weeks.

The ordinary cesspool may be a water-tight structure or a kind of septic tank. Sometimes cesspools have porous or loosely constructed walls, which act like the subsurface drainage tiles (see Fig. 39). Where houses are close together, or where wells may be contaminated, the tight cesspool is more desirable. Cesspools are preferably constructed in pairs (see Fig. 40), one a true septic tank and the other a leaching (G) pit. In such paired cesspools, the first or septic tank is usually made water-tight (extra inside coatings of pure Portland cement), though the grease collecting on the sides tends to make it quite waterproof, anyhow. If the inflowing pipe ends low down in the first (right) tank, the grease film on the top is

not broken as the sewage flows in, and better putrefactive[1] action may be secured. The carry-over pipe carries over the liquid, leaving the solids yet undigested in the bottom. In some cases the second cesspool empties into subsurface drainage pipes; in many cases the leaching is from the cesspool itself, as shown in this figure. Cesspools should always have an overflow pipe. If tight or lined cesspools become clogged, sewage may back up into the house; an overflow would call attention to the difficulty before this occurred.

Contact Beds.—The double cesspool has, therefore, bacterial action of both types—mainly putrefactive in the first part, and mainly oxidative in the second. The "contact beds" have both types also. They are simply huge open shallow basins or beds of broken stone, brick, etc., into which the sewage is poured. These beds are flooded for a short period (two hours) and then emptied; empty and filled periods alternate. When filled, putrefaction takes place in the liquid mass; at the surface and near the spaces in the bottom the action is oxidative. When the bed is empty, oxygen enters the spaces and the substances clinging to the stones in the bed are oxidized by the bacterial film also on those stones.

Combined Methods.—Omitting the mechanical or chemical clearing of sewage, all the above methods of specially treating sewage fall under the headings of oxidizing processes or putrefactive processes.

Action	
Oxidation	Putrefaction
Broad irrigation	
Subsurface drainage	Cesspool (tight-walled)
Intermittent filter	Septic tank
Trickling filter	
Activated sludge	
Cesspool (loose-walled)	

Combined action
Contact bed (mainly oxidative)
Double cesspool

[1] As "starters" for tight cesspools and septic tanks one or two shovelfuls of manure are sometimes used.

Bacterial Reduction.—The various methods differ in the rate at which sewage bacteria are destroyed; *e.g.*, fine screens reduce the bacteria only 10 to 20 per cent., sedimentation 25 to 75 per cent., chemical precipitation 40 to 80 per cent., contact beds 80 to 90 per cent., activated sludge process 85 to 95 per cent., and trickling filters 90 to 95 per cent.

They differ also in the rate at which sewage is "purified." Subsurface drainage can take care of 150 to 200 people per acre drained; intermittent sand filters, of 1500 to 2000 people per filter acre; contact beds, of 5000 per acre, and trickling filters, of 10,000 or more per acre. A house or a community may use one device only or more than one. The selection depends upon the character of the soil, the number of people to be served, the place of final discharge, and upon whether or not the effluent (G) is to be used.

Disinfection.—In some cases such reclaimed water is used for factory purposes. Such water should be disinfected, though people sometimes drink it with no evil results. Sewage that is in a partly decomposed state during or after the process above described may be dangerous. It depends upon how completely the changes undergone have affected any pathogenic bacteria originally in it, or how completely such bacteria have been removed by filters, etc. The proximity of exposed sewage to residences is, of course, important in deciding whether disinfection is necessary.

Trade Wastes.—Streams and lakes are sometimes polluted by trade wastes, which are objectionable but are not usually directly dangerous to health. Indirectly they may be very important: some wastes give objectionable colors or tastes to water (*e.g.*, dye, gasoline, and petroleum wastes), cutting down thereby the potable (G) water available to the community; acid wastes may dissolve cement basins, etc.; others, such as paper-mill wastes, may interfere with the later filtration of community water. In some towns a factory may discharge more waste than the rest of the town; such wastes are sometimes high in organic material, adding materially to the whole sewage-disposal problem. All extensive processes, such as slaughtering, tanning, discharging such objectionable wastes should include private disposal systems (chemical treatment, sedimentation, and filtration) which would protect the community.[2]

[2] Incidentally, this would be a great economic gain (*e.g.*, compulsory treatment of such wastes nets paper mills 15 cents a gallon for the sulphite waste).

Cost of Sewage Disposal.—Sewage disposal can never be made a source of income. The total solids are very low—less than 1 per cent. The sludge is valued at but one to four cents per ton; and cannot, therefore, be a source of income. London has two millions of tons of sludge yearly to give away, but is forced to go to the expense of carrying it fifty miles out to sea, because no one wants it even at that low price. The use of human excreta in China, Korea, etc., has led people to bemoan our prodigality. As indicated earlier, untreated human excreta should not be used for vegetables; chemical treatment brings the expense up to the cost of ordinary and less objectionable fertilizers; the idea is, besides, displeasing to Americans. The results obtained on sewage farms make Victor Hugo's lengthy and heated arguments for utilization of the sewage of Paris interesting only from a literary point of view.

PROBLEMS

1. How does your community dispose of its sewage?
2. How many methods of sewage disposal are in use in a two or three-mile radius of this building? Is any of them a menace to health?
3. Has any building in your community a privy or pail closet, or a dry-earth closet which is not properly attended to? What would it cost (money or time) to make it safe for the neighbors?
4. What are the possible dangers attending the use of cesspools?

See Reference List at end of Appendix.

CHAPTER VIII

REFUSE DISPOSAL

THE disposal of waste water (*e.g.,* dishwater) and human excreta is discussed under sewage disposal. The other principal house wastes are sweepings (lint, mud, soot, grit from pavements), ashes, garbage, and rubbish; this last term includes such materials as old glass and tin articles, paper and rags. In cities or towns is added the disposal of sweepings from the street (earth, grit, horse manure) and from common vehicles, *e.g.,* street cars.

Rosenau estimates that in New York City such wastes total about a ton per person every year: ashes, 1200 pounds; garbage, 200; rubbish, 100, and street sweepings, 300 pounds. In smaller cities this is much less, but the relative cost per person does not decrease so rapidly.

Prompt Removal Desirable.—Refuse disposal is demanded by the generally accepted standards of cleanliness and convenience. The accumulation of foodstuff materials generally known as garbage may allow the development of flies, though garbage is very rarely allowed to stand long enough for that, as it takes ten days from the egg stage to the full-grown fly. Tin cans or other water-holding rubbish often lie around for longer periods; accumulations of rain-water make possible new broods of mosquitoes every ten days. Garbage should, therefore, be removed daily during fly-time; tin cans, etc., should be removed at least weekly.

Garbage Cans.—The principal hygienic danger is due to the fact that the odors of decomposing garbage attract flies from still more undesirable localities, *e.g.,* privies containing excreta of people having dysentery or typhoid. Garbage cans should therefore be odor-tight as well as fly-tight. It is probably unnecessary to add that they should be water-tight, for otherwise leakage from the can will cause the accumulation of evil-smelling substances in the soil around it. Cans and any soiled area around them should be well sunned; if odors persist, burning with oil is a cheap cure. Rinse the oil around in the can, leaving a little in the bottom—but *a half inch or less*—and start the flame by dropping a match on a piece of paper or other kindling material. Soiled ground can be burned

in this way. Such treatment is rarely necessary, and should be done by careful persons because of the danger from fire. The lid should be left off, of course. Garbage-can lids should fit so well that they can not be knocked off by cats or dogs. Garbage should never be left uncovered at any time, not even when on the street awaiting collection. Even "nice" people expose such disgusting masses daily to the view of all passers-by if stringent health rules do not prevent.

Disposal of House Garbage.—If the community has no refuse disposal system, each house must care for its own garbage. In some localities it may be simpler to bury it, remembering that the less soil one uses as a covering the more rapidly the material will disintegrate. The soil must be deep enough to prevent the attraction of flies; dogs or cats often dig up such deposits, if covered too lightly, and one must consider all of these factors in disposing of garbage by burial.

Wire baskets, fitting back of and above the fireplace grate, can be used for drying garbage so that later it can be burned readily in the grate. Stovepipes are sometimes made with an enlargement in which a wire basket of refuse can be quickly dried. If the mass of garbage is large or too tightly packed, it may interfere with the draft somewhat, as well as delay rapid drying. Chimneys can, with little extra trouble at the time of construction, be made with an outside opening into the flue in which such material can be dried. The door to this opening must, of course, be kept tightly closed to avoid interfering with the draft.

Home Disposal of Other Refuse.—In the individual home papers can be burned, unless the methods of heating and cooking in use do not include either stoves or furnaces. In those cases, incinerators (skeleton baskets or wire frames) may be used, the resulting ash being utilized on the flower beds or lawn. Often these incinerators can be used for the partial sun and air drying of such garbage as bean or pea shells and corn husks; they may then be burned readily, especially if mixed with the daily accumulations of paper, etc. Ashes are more of a problem, unless they can be used to fill in, for paths, etc. Bottles, tin cans, and old bedsprings are always a problem—even in the country, as illustrated by the frequency with which one runs across deposits of such materials on the edges of towns or in out-of-the-way places.

Collection of Community Refuse.—When, because of the closely populated character of a community, these problems become too difficult, community systems of collection and disposal become necessary. These may mean only the removal of ashes in winter, or of garbage in summer. The *method* of collection, too, varies; all kinds of house refuse may be dumped into a common cart, or the various types may be collected separately; (1) ashes, (2) garbage, and (3) papers and similar inflammable materials; tin cans, bottles, etc., are usually collected with the rubbish. The method of collection depends upon the method of disposal.

Dumping as a Method of Disposal.—Refuse dumped out at sea may be washed back to the shore and become a decided nuisance, especially if it includes garbage. When there is no low ground to fill in, coast towns often dispose of such wastes at sea. Inland communities often fill in old quarries, marsh lands, etc., with mixed refuse. These pits are usually great nuisances, giving forth vile odors and breeding mosquitoes and flies. Such eyesores have also a bad effect upon the community spirit and hygienic standards of any locality. Occasionally such pits are flooded with oil and burned over, but this burning is usually most incompletely done, and practically does little more than add to the odors already unbearable to the unfortunates residing within short distances. Within the last year a community within sight of New York City was still maintaining a huge pest-hole of this kind nearly a quarter of a mile long and within a few feet of a main road!

Other Methods of Disposal.—Adequate methods of refuse disposal are usually much more complicated. There are two distinct methods: incineration and reduction.

Incineration.—Mixed refuse is adapted to the incineration method; the tin, glass, etc., are picked or sorted out, and the rest is burned in huge furnaces or incinerators, the paper and ashes forming sufficient fuel to dry and burn the garbage. The end products are ashes and steam. This ash is, of course, burned at a high temperature, often over 650° to 1100° C. (1202° to 2012° F.), and is free from odors, organic or decomposing substance, as well as bacteria. The steam may be used for heating or outside commercial purposes as well as operating the disposal plant; where power is expensive this method may actually be a source of revenue to the community, being sold as steam or in the form of electricity.

In Minneapolis the refuse accumulation of each day must be wrapped in paper. This insures good mixture of inflammable paper, and leaves more air spaces in the mass to be burned. Every square foot of grate surface can take care of one-half to two-thirds of a ton of refuse in a day; if properly done, there is very little odor or smoke. This method is more popular in Europe than in the United States. It has certain advantages in regard to collection: the ashes soak up the water, preventing dripping, and they do not, therefore, form objectionable dust during collection and carting.

Reduction.—Reduction is more popular in the United States than abroad. The separation before collection yields ashes for filling, and paper, which may be used in paper making. The garbage is the part that undergoes reduction. While the apparatus performing the work of reduction is far from simple, the theory can be very simply explained by reference to the diagram following (Fig. 41). In the best systems the garbage is not handled by hand at all after it is dumped into the collecting cart. The scows which carry it to the reduction plant have a tank at one end into which the water from the garbage is allowed to run off during transit. Huge canvas sheets are hung between the scow and the reduction plant, and as the material is dumped into the first tank or container (1) the undesirable substances, such as the larger bones, are picked out by machinery. This first tank is a steam-lined chamber where the material is heated eight to ten hours, at a pressure of sixty to one hundred and forty pounds. During the heating in this tank the material is flooded with naphtha or other similar volatile substance not miscible with water and having a higher boiling point than water. Both the water from the garbage and the added naphtha are continuously vaporized and drawn off into a tank (C) where they are condensed to liquid form again and the naphtha and water are separated by gravity. The water is discarded, but the naphtha runs back into the tank to be used again. This heated garbage is constantly stirred until it becomes a dry mass, when it is again flooded with the naphtha and the grease extracted. The grease extracted may represent 1 to 3 per cent. of the garbage. The dry mass left in tank (1) after the grease is extracted is dumped upon a coarse screen (2), where the coarser particles (bones, rags, etc.) are taken out, and on to another finer screen (3) where the finer material drops through into the hopper (H), but the

coarser particles pass on to a grinder and then afterward they are screened and collected into the same hopper (H). The material collected in the hopper is used in making fertilizer. The bones are ground up and sold; the rags are also marketable.

In the system described the heating is done in a closed tank, and at no time do odors or gases escape to the outside air; the products are all sterilized before they are discharged, so there is no nuisance or danger connected with properly constructed and managed reduction plants. The process is a very quick one—the whole process as described being complete in twelve hours. About 20 per cent. of the garbage is marketable tankage, which can be put upon the ground directly, or used as a filler for fertilizer.

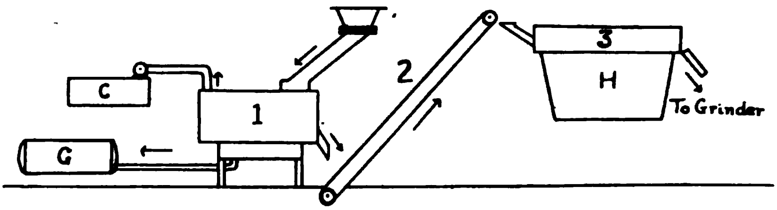

FIG. 41.—Diagram of a garbage reduction plant. Garbage is received through the funnel-like opening above 1. G is the gravity tank for separating water and naphtha. See text for other details.

Other Uses of Separated Refuse.—When refuse is collected separately the garbage is sometimes used to feed pigs. If discontinued a few weeks before the pigs are killed, there is no objection to its use for this purpose. The garbage should be fresh; if not collected daily, it should be sterilized by steam. This cooked garbage may be mixed with grain. Garbage is sometimes sold to private parties, though there are a number of community "piggeries," about 300 in the whole United States, which together are credited with an annual production of 52,000,000 pounds of pork.

The tin cans in the refuse are sometimes melted to reclaim the tin.

The money value represented in garbage may be guessed at when one reads that a private corporation paid the United States nearly $450,000 for the garbage in the stationary camps established in the United States the first year after our entrance into the war. Recent Federal reports claim that from a ton of garbage may be ob-

tained enough glycerin for fourteen shells, enough fat and acid for seventy-five pounds of soap, and enough fertilizer for eight bushels of wheat. This is not so severe an arraignment of small communities as large ones, because the paying recovery of such substances is only possible in specially constructed plants and by trade processes.

PROBLEMS

1. Name the ways in which improper methods of refuse disposal affect health.

2. What is the method of refuse disposal used in your community?

3. Name the most important products resulting from the economic destruction of garbage; illustrate by towns in your own State.

4. Formulate a set of rules for the household covering the disposal of refuse.

5. The first garbage reduction plant in the United States was established but twenty-seven years ago in New York City; has this affected the methods used in your State?

6. What should be done with house refuse in the farm home?

See Reference List at end of Appendix.

CHAPTER IX

TRANSFER OF DISEASE

Early Theories.—Although 1675 is the earliest date one can give for the actual observation of bacteria, there were advanced still earlier at least two theories of the transfer of disease which presupposes the existence of such minute organisms.

Fracastorius, in 1546, described these causes of disease as being of a glutinous nature, capable of reproduction. Kircher, in 1659, described minute living worms in milk, vinegar, cheese, and putrid substances, saying that they "swarmed with an innumerable brood of worms which are imperceptible to the naked eye."

In 1675 Leeuwenhoeck, a Dutch lens maker, studied the living organisms present in saliva, diarrhœal excreta and putrid substances. Even though his lenses were far superior to all previously made, the organisms he described were probably mainly protozoa; some suggest streptococci, and there is little doubt that some of the larger motile bacteria were seen. That he called them animalcules (little animals) means nothing, for in his time motility was thought to be an animal characteristic; they knew nothing of the many tiny free-swimming plants at that time.

Modes of Transfer.—That disease may be caused by a transfer of pus or other material from external lesions (G) was recognized long before these dates, however. Even before the Christian era lepers were compelled to avoid contact with other people; the few who were cured had to burn their old clothing, bathe, and substitute fresh clothes before returning to their former homes.

The Chinese also transferred smallpox in a mild form from the sick to the well by wetting wool with pus from the eruptions, and placing it in the nostrils of the person who desired to contract the disease and so secure immunity. The Turks later transferred smallpox by inserting pus from an afflicted person directly into the blood of a well individual, making a small scratch or prick in the skin to inoculate the pus.

These early theories also included surmises regarding the agents of transfer of such infectious material.

Air, as a transfer agent, was mentioned by Fracastorius as early as 1546. In fact, air has always very generally been accepted as a transfer agent. It has even shared with "Divine Providence" the unenviable reputation of a causal agent. Even in the last century night air and marsh air were generally dreaded and avoided. The Rollo books of the last generation described the passengers in an Italian coach as sleeping with all the windows shut to avoid the pestilential effect of the "night air" as they travelled over certain malarial regions.

The rôle of insects responsible for the fear of "night air" in the instance just described was suspected long before it could be proven. Before the Middle Ages Indian writers tried to relate infection and the mosquito, a theory it took several centuries to prove (malaria, 1896 or 1898; yellow fever, 1901).

Kircher, in 1658, definitely mentions flies as transfer agents, saying "there is no doubt that flies feed on the internal secretions of the diseased and dying; then flying away, they deposit their excretions on the food in neighboring dwellings, and persons who eat it are thus affected."

It is now known that disease organisms may remain suspended in air; especially when associated with fine particles of dust or lint, which act as buoys. As will be shown further on in this chapter, it is unusual for diseases to spread any considerable distance by air alone. The indications are rather that the transfer is usually more direct—by contact. And the modes of infection are often classified under three headings: (1) direct transfer; (2) indirect transfer; or (3) transfer through an intermediate host.

Types of Transfer.—Contact may be direct—as when nasal excretions of a measles case are transferred by a common handkerchief to a second individual. When the contact is made by food (including milk), air, water, and soil, it is usual to speak of the transfer or contact as indirect. One grades into the other.

The transfer—more or less direct—by means of saliva are very graphically described by Chapin:

"Not only is the saliva made use of for a great variety of purposes, and numberless articles are for one reason or another placed in the mouth, but, for no reason whatever, and all unconsciously, the fingers are with great frequency raised to the lips or the nose. Who can doubt that if the salivary glands secreted indigo the fingers would not continually be stained a deep blue, and who can doubt that if the nasal and oral secretions con-

tain the germs of disease these germs will not be almost as constantly found upon the fingers? All successful commerce is reciprocal, and in this universal trade in human saliva the fingers not only bring foreign secretions to the mouth of their owner, but there, exchanging it for his own, distribute the latter to everything that the hand touches. This happens not once, but scores and hundreds of times during the day's round of the individual. The cook spreads his saliva on the muffins and rolls, the waitress infects the glasses and spoons, the moistened fingers of the pedlar arrange his fruit, the thumb of the milkman is in his measure, the reader moistens the pages of his book, the conductor his transfer tickets, the "lady" the fingers of her glove. Everyone is busily engaged in this distribution of saliva, so that the end of each day finds this secretion freely distributed on the doors, window sills, furniture, and playthings in the home, the straps of trolley cars, the rails and counters and desks of shops and public buildings, and, indeed, upon everything that the hands of man touch. What avails it if the pathogens do die quickly? A fresh supply is furnished each day. Besides the moistening of the fingers with saliva and the use of the common drinking cup, the mouth is put to numberless improper uses which may result in the spread of infection. It is used to hold pins, string, pencils, paper, and money. The lips are used to moisten the pencil, to point the thread for the needle, to wet postage stamps and envelopes. Children 'swap' apples, cake, and lollipops, while men exchange their pipes and women their hatpins. Sometimes the mother is seen 'cleansing' the face of her child with her saliva-moistened handkerchief, and perhaps the visitor is shortly after invited to kiss the little one."

Chapin also describes kissing as a "recognized mode of direct contact infection. The certainty of this mode is illustrated by a well authenticated incident recently recorded. At a small party of young people, where kissing games were not debarred, there happened to be a young man with a syphilitic sore on his lip. As a result of the party eight of the young people contracted syphilis. In a boarding school a girl, while beginning to develop the sore throat of scarlet fever, received her friends in her room. The only one who contracted the disease was the one who kissed her. There was no infection of the air of that room and the disease spread to no one, but by direct contact. Numerous other instances attest the importance of this mode of infection. Of course, it is expected that lovers will continue to brave this source of danger, but is it not reasonable to ask others to reform? Gushing women, who kiss their neighbor's children, and schoolgirls who use this salutation as freely as a shake of the hand, should learn that this meaningless use of the kiss disregards the canons of good taste, as it certainly does sanitary precepts."

Most of our common diseases are apparently transferred by direct contact, though the list of those due to insects and other intermediate hosts is growing rapidly and includes some of our most dreaded diseases, such as yellow fever, typhus fever and plague. Flies which carry typhoid organisms from the fæces of one person to the food of another person, play the same rôle as water, and typhoid so transferred might be described as due to indirect con-

tact (Figs. 42 and 43). In many other cases, the organisms grow and multiply in the bodies of insects, multiplying greatly the chances of spreading such diseases. This is transfer through an

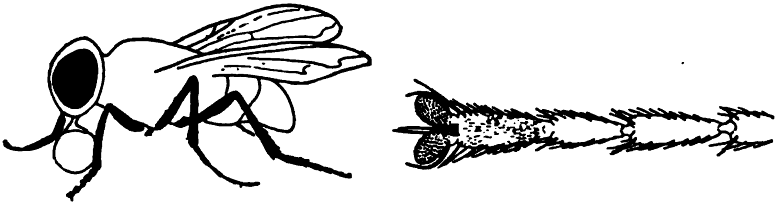

FIG. 42.—On the left the fly is shown in the act of regurgitating material; this causes the fly "spots" familiar to all. Note on the right the hairy rough character of the foot (much magnified), which explains why so much material adheres to it. See Fig. 43.

FIG. 43.—A plate of agar over which a small insect walked. Howard speaks of "the fly which does not wipe its feet." Show that where he wipes them is also important.

intermediate *host.* This is sometimes called biological transfer, and direct or indirect contact transfer is called mechanical transfer.

These terms are not given to emphasize any importance now attached to them, but to explain their usage, as they are in quite

common use. Two other terms which have been the source of great confusion and much useless discussion are contagious and infectious. Any disease that can be transferred from one individual to another is contagious. All such diseases are, of course, due to micro-organisms or infectious organisms. Since contagious diseases are all infectious, and most infectious diseases are contagious, the terms have always been troublesome. Much simpler is the use of the word communicable for all diseases that can be transferred from man to man, including in it those transferred by indirect as well as direct contact. In contrast to communicable diseases (typhoid, tuberculosis), we have the diseases transferred by an intermediate host (malaria, yellow fever).

To fully understand the transfer of communicable diseases, we must know at least three things:

(1) How the causal organisms leave the body of ill people;

(2) How they are transferred to other subjects;

(3) Their preferred channels of infection or entrance into other subjects.

Consult the following table (pp. 173-4) for condensed information on these topics for our most common communicable diseases. Does this table justify the warning regarding the four F's—fomites (G), flies, fingers, food?

Channels of Infection.—In how many of the diseases listed does the route of transfer indicate the great danger in the very common habit of coughing or sneezing directly into the air? The more direct the route, the greater the chances of infection, for direct contact transfers organisms usually much more vigorous than those which have been for hours exposed to somewhat unfavorable conditions, such as drying, effects of sunlight. The "channel of infection" (or method of entering the body) is quite definitely fixed for some organisms, for example, typhoid. This organism ordinarily causes disease only when it gets into the alimentary canal, and though it may be found in the blood during illness, its normal and one constant habitat is the lining of the small intestine. Tuberculosis illustrates remarkably well our inability to predict always the mode of entrance from the lesions which are found in affected people. Even in pulmonary tuberculosis there is every reason to think that the preferred entrance is not by the lungs but by the alimentary tract and that tubercle bacilli entering with food

COMMUNICABLE DISEASES—NOT NEEDING AN INTERMEDIATE HOST FOR TRANSFER

Disease	Organisms leave the body	Known methods of transfer	Preferred channel of entrance
Smallpox [1]....	Secretions from mouth and nose; fæces and urine; (?) lesions	Personal objects (handkerchiefs, spoons, etc.), bedding; flies	Probably through the respiratory mucous membranes
Syphilis......	Lesions, infected tissues	Direct contact with diseased; mouth lesions to cups, spoons, pipes, dental instruments; or any lesions to towels, bedding, razors, or via hands to food	Directly into blood or tissues through breaks in the skin or through delicate membranes, as in genital organs
Gonorrhea....	As in sypnilis.....	As in syphilis; more often transferred by toilet seats, bath tubs than syphilis, especially to children	As in syphilis. Eyes often directly infected, especially at birth
Ophthalmia neonatorum	Usually a gonorrheal infection	At birth during passage through genital tract, or by hands of infected nurse, physician	Eye
Trachoma....	Eye lesions.......	Towels, handkerchiefs, fingers	Eye
Tetanus......	Common in normal excreta of herbivorous animals, including man	Through soil, dust, etc., infected with fæcal material; occasionally transferred by soiled hands, instruments, catgut	Directly into blood or tissues through wounds
Typhoid......	Urine or fæces....	Mouth to dishes, thermometers, tongue depressors or transferred by kissing; more often by hands, bedding, etc., soiled with fæcal matter to milk, food; carried from fæces, etc., by flies to food; fæces may pollute water; vegetables grown in polluted soil (water cress, or lettuce) may transfer it	Through mouth to intestine

[1] Really belongs with diseases from lower animals (p. 179).

COMMUNICABLE DISEASES—NOT NEEDING AN INTERMEDIATE HOST FOR TRANSFER—(*Continued*)

Disease	Organisms leave the body	Known methods of transfer	Preferred channel of entrance
Tuberculosis (Human)	Sputum mainly; also lesions; fæces occasionally	Kissing, droplet infection (coughing, etc.) to food, contact soiled fingers or personal objects	Through mouth; usually via the intestines to lymph vessels and then to tissues, even lungs
(Bovine)[2]...	Diseased udder or fæces	To milk............	As above
Diphtheria...	Discharges mouth and nose	Direct contact, as kissing; via fingers or any object in contact with mouth or fingers, including droplet infection	Throat—usually localized there
Measles......	As in diphtheria, especially nose	As in diphtheria.....	Probably mainly through nose
Scarlet fever..	Probably as in diphtheria	As in diphtheria.....	Mouth and nose probably
Whooping cough	Secretions of nose, respiratory tract	As in diphtheria.....	Mouth or nose
Mumps......	Secretions of mouth (salivary glands?) and nose	Direct contact, much as above	Probably mouth (or nose)
Pneumonia...	Mouth, nose and respiratory tract	As in diphtheria.....	Mouth and nose
Influenza.....	As in pneumonia..	As in diphtheria.....	Mouth and nose
Common colds	As in diphtheria...	As in diphtheria.....	Mouth and nose
Meningitis...	As in diphtheria, especially nose	As in diphtheria.....	Mouth and nose
Infantile paralysis	Probably as in meningitis	Direct contact, much as above? Stable fly?	Mouth and nose
Cholera......	Excreta..........	Much as in typhoid..	As in typhoid
Dysentery....	Excreta..........	Much as in typhoid..	As in typhoid
Hookworm...	Excreta..........	Much as in typhoid..	Mostly as in typhoid; about 10 per cent. through skin (bare feet, infected toilet seats?) (Fig. 44)
Leprosy......	Uncertain; lesions, probably also sputum and fæces	Probably by direct contact; flies and other insects	Uncertain

[2] Really belongs with diseases from lower animals (p. 179).

or drink are washed down into the stomach and make their way from the intestinal area to the lymphatics and from them to the tissues, including the lungs. (This is supported by experimental work and by autopsies where the oldest lesions are found in the intestinal region, younger ones in the lymph nodes, and still younger ones in the lungs themselves.)

These preferred methods of entry are illustrated by the following experiment. If typhoid, streptococci, and diphtheria organisms are

Fig. 44.—Hookworms making their way into the skin. These are two to four times natural size.

rubbed on a cut in the skin, such as the hand, the cut with typhoid produces no lesion at all, the diphtheria but a slight one, but the streptococci-infected cut usually produces a severe infection, sometimes a general and fatal blood-poisoning. If the same bacteria are rubbed on the throat, the typhoid produces no effect, the streptococcus causes a sore throat or blood-poisoning, but the diphtheria causes typical diphtheria. If the three are given in food, typhoid only is harmful, producing typhoid fever. Tetanus, similarly, causes lockjaw when the organisms get directly into the subcutaneous tissue; a horse's intestines commonly contain tetanus

organisms, but it is only when some of those organisms—probably from the animal's own manure—get directly into the tissues, as in a nail puncture of the hoof, that the horse develops lockjaw.

Hookworm (Fig. 44) takes a most curious path through the human body. It may be taken in with food and water as indicated in the table; but the organisms may penetrate the skin (*e.g.*, bare feet) and find their way to the lymph-vessels, then to the heart and lungs where they are coughed up into the throat; there they are swallowed, lodging in the small intestine.

Human Carriers.—Not only the ill, but often the well, should cry "unclean," for healthy human beings may act as carriers of disease organisms. Such carriers have usually had the disease in question, and retain virulent organisms (G) for a time after they have recovered. Diphtheria carriers are quite common. It has been estimated that 2 to 3 per cent. of all diphtheria cases become carriers, and 1 to 5 per cent. of all typhoid cases. Meningitis carriers are so common that Rosenau states that it would require military aid to quarantine all the meningitis carriers. They have been one of the big problems in our military camps in the present war.

The history of some of these carriers has been most surprising. One epidemic of over 400 typhoid cases in New York City was traced to an employee in a dairy who had had typhoid forty-nine years before; another in Washington (D. C.) to a man who had had typhoid forty-five years previously. "Typhoid Mary" has had more than her share of attention, owing to her detention for three years in an effort to overcome this condition. Before her detention she had a record of at least twenty-two cases of typhoid in seven different households, the cases developing in practically every instance two to four weeks after her arrival. On giving her parole not to cook, she was released; and at her own request given work in one of the city institutions. She disappeared, however, and a few years afterward was located as cook in a maternity hospital where twenty-five typhoid cases had already developed. It was then learned that since her release she had also infected a friend and several people in a small sanatorium.

Houston describes several interesting carriers in England. One was the wife of a master baker with whom the apprentices boarded;

practically every apprentice became ill (stomach and intestinal disturbances) shortly after entering into apprenticeship. This was interpreted by her as due to "too good diet." Finally one of the new apprentices died of typhoid, when the woman herself was discovered to be a carrier.

Another is the case of a cook and dairymaid in a reformatory where she caused twenty-three cases of typhoid in one summer, one being the gardener's wife, who had received nothing from the institution except milk; a second was an outdoor policeman who was given a daily allowance of milk for his tea. After the twenty-third case, she was excluded from kitchen and dairy work and no new cases developed. She had had typhoid five years before, and was afterward found to be a carrier; past history indicated that she was responsible for outbreaks in at least two other institutions.

Intermediate Hosts.—The third method of transfer—by intermediate hosts—includes rabies, foot and mouth disease, bovine tuberculosis and cowpox. The last two were included in the previous table; bovine tuberculosis could be treated more easily with human tuberculosis, and cowpox and smallpox are but different phases of the same disease. Rabies and foot and mouth disease are transmitted to man only by the lower animals—so they are placed in the same table on page 179. Here, too, should be placed, if present knowledge sufficed, a new, persistent mold disease recently described as due to bites of mice or similar infections. Such intermediate insect hosts may affect us also indirectly through our food supply, *e.g.*, the tick which causes Texas fever in cattle (Fig. 45).

Micro-organisms which are transferred by intermediate hosts are commonly located in the blood, salivary glands, stomach or intestines of these insects. Protozoa differ from bacteria in that many of them go through a series of definite changes or phases—a life cycle. In the mosquito the organism causing malaria passes through several peculiar stages in the stomach, lymph, and the so-called "salivary glands" connected with the biting apparatus, whence they finally make their way into the blood of human beings, where other peculiar stages develop. In diseases like malaria (Fig. 46) and yellow fever, where the parasite goes through part of its development or serial changes in one animal (man) and part in another (mosquito) both animals are necessary to complete the whole cycle of changes, and the disease is usually not transferred

until certain stages adapted to the conditions met in the other host have been reached. To reach these transfer stages takes several days, usually. For example, mosquitoes cannot transfer malarial parasites to man until they have undergone twelve days of such cyclic changes in the mosquito. Yellow fever mosquitoes must obtain that parasite from a yellow fever patient during the first three days of his disease, and they cannot transfer it to other people until about twelve days have passed; they retain organisms in that transferable stage the rest of their lives, however.

FIG. 45.

FIG. 46.

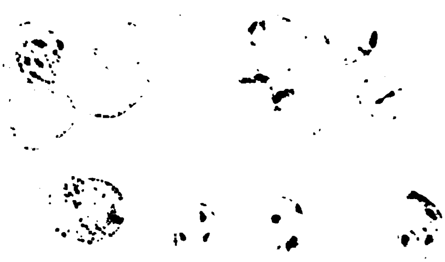

FIG. 45.—The somewhat pear-shaped bodies in the red blood-corpuscles are the protozoa which cause Texas fever; they are transferred through the bite of the tick. Note the abnormal shape of the blood-corpuscles.

FIG. 46.—This illustration shows normal red corpuscles from human blood; find corpuscles containing one malaria organism; three such organisms. Explain why malarial people are often anæmic.

Such peculiarities made it very difficult to trace disease transfer at first. Now, when we find limited transfer and non-transfer periods, we are very sure that the causal organisms have such cycles in their development, that they are protozoa, not bacteria. For example, the organism causing yellow fever has never been seen, but any bacteriologist on the data just described would risk his reputation on its being a protozoön.

Almost all the human disease organisms having other animals as alternate hosts are protozoa. Two or three are due to molds, one or two to true bacteria (*e.g.*, plague caused by *Bacillus pestus*). The following table gives a list of common diseases spread through such alternate hosts:

COMMON DISEASES IN MAN CONTRACTED FROM OTHER ANIMALS

Disease in man	Other host or hosts	Parasite [3] causing disease (Protozoa except in the diseases numbered 3)
Insect hosts:		
Malaria	Many species of mosquitoes (mainly *Anopheles*)	*Plasmodium* (*Hæmamæba*) (Fig. 46)
Yellow fever	One species of mosquito (*Stegomyia calopus*)	Not yet seen
Sleeping sickness	The tsetse fly (*Glossina*)	*Trypanosoma* (Fig. 3)
Relapsing fever	Bedbugs, lice, ticks, biting flies	*Spirochæta*
Plague [4]	[4] (1) Fleas, (Xenopsylla and Ceratophyllus); (2) rats, ground squirrels and related rodents	*Bacillus pestus*
Typhus fever [4]	The body louse (Pediculus), less often the head louse	Probably *Bacillus typhi-exanthematici*
Other hosts:		
Rabies	Dog (horse, cow, skunks and other animals bitten by dogs)	Doubtless "Negri bodies" demonstrated in nervous system; transferred to man by dogs biting, licking breaks in skin
Foot-and-mouth disease	Cow and sheep mainly; transferred to man usually through milk	Not yet isolated
Anthrax [3]	Cow, horses, sheep, mainly; transferred to man through infected hides, furs, bristle brushes, etc.	*Bacillus anthracis*
Trichinosis [3]	[4] Pig and rat (also dogs, cats, foxes, etc.)	*Trichinella* (a round worm commonly called trichina)
Tapeworm [3]	Pig, cow, dogs all harbor tapeworms, transferable to man through meat or by dog licking hands	Three species of Tænia (a flat worm)

[3] See Figs. 3 and 4 also for drawings of typical protozoa.

[4] In both of these drawings, plague and typhus, the main host is the rat. Fleas, if their normal food animal, the rat, is lacking or limited in number, attack man, thus bringing him into a rat-flea-man chain. Pigs often eat rats or offal from slaughter houses or fæces containing the worms; since man eats pork, a rat-pig-man series is therefore established.

This list may some day have added to it other common insect hosts: the bedbug for tuberculosis and leprosy, and the stable fly for infantile paralysis. At present, evidence does not warrant including them in this list.

Direct Control of Intermediate Hosts.—The control of these diseases transmitted to man by insects or other small animals is accomplished by breaking the chain.

This may be broken in several ways: (1) by getting rid of the intermediate host. Without rats, no plague; without mosquitoes, no malaria. There is no reason why more energy and money should not be expended in getting rid of rats, animals both filthy and destructive in habits. The economic loss to farmers and to big business houses (textiles, grains, and other foods) is estimated at thirty-five to fifty million dollars yearly.[5] Though it seems a hopeless task, any reduction in their numbers is to be welcomed. Pest-ridden cities have conducted campaigns (poisons, traps, and fumigation) with good results.

Indirect Control Through Environment.—(2) Other intermediate hosts, such as the mosquito, are still more difficult to exterminate. Although the Panama Canal is a wonderful monument to sanitary science in its control of yellow fever, it must be remembered that that was a relatively small area when compared with our whole country, and that such scientific and complete control of the whole United States is not possible, without some degree of federal health control.

The extension or spread of malaria, yellow fever, and similar insect-borne diseases to entirely new areas is usually due to an infected person who migrates to that region and infects the mosquitoes, who spread the disease by biting other people. Insects themselves do not travel far, unless carried (trains, wagons, etc.).

Control Through Care of Excreta.—(3) A third way of limiting the transfer of diseases due to intermediate hosts is by greater care of our body wastes. Unclean habits in cattle yards or in the fields where pigs and cows are kept, make it possible for these animals to become infected with the tapeworm eggs. Dogs

[5] See the National Geographical Magazine for July, 1917, for a well illustrated description of the rat peril.

that run at large become infected with eggs from sheep, pigs and cows; such dogs may be dangerous pets, for the eggs from fæcal material which they transfer to man when licking his hands, may promptly find their way into the human intestine.

Control Through Food.—(4) In a few cases, man may break the chain by proper treatment of his food; underdone beef and pork may transfer their respective tapeworms. The large amount of cold-storage meat in our present meat supply is a great safeguard, for cold storage from twenty-one to twenty-nine days kills beef and pork tapeworms and trichinas. Pasteurization of milk destroys bovine tuberculosis (as well as human organisms that may find their way into it).

In diseases transferred from man to man, we endeavor to prevent their spread by disinfection and by framing rules of conduct with regard to our foods and personal habits. While these are implied more than once—in this and other chapters—it may be of service to repeat them here:

(1) Avoid the use of articles or appliances used in common: towels, soaps, drinking cups, pencils, etc.

(2) Wash the hands thoroughly after handling articles used in common and before eating.

(3) Eat and drink less from unknown sources.[6]

(4) Avoid crowded places, especially in epidemics of colds, pneumonia and influenza.[7]

(5) Support and insist upon the reporting of communicable diseases, that quarantine and disinfection may help prevent further transfer of disease. In some cases it may be your duty to be vaccinated against virulent diseases, such as smallpox. (See Chapter X.)

(6) Having framed such a set of rules for general conduct, adhere to them; make them a matter of habit and forget the reasons. It is almost as foolish to think constantly of the reasons why these rules are wise and necessary, as it is to refuse to consider or follow them. The former is depressing and probably injurious to you; the latter, dangerous not only for you but for your whole community.

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[6] Most people eat constantly while out on a picnic or jaunt, and almost without question as to the effect upon the digestive apparatus or as to the bacterial cleanliness of the food consumed.

[7] If transit companies cannot be forced to supply sufficient transportation facilities, slightly varying working hours should be arranged (beginning at 8.15 instead of 8, closing at 5.30 instead of 5) for several of the biggest corporations, schools, etc., thus lessening the danger through crowded conveyances.

PROBLEMS

1. List the habits or actions noted in one day that would help spread a throat or nose infection, such as a common cold.

2. What mechanical devices can you suggest for decreasing such opportunities for transfer (*e.g.*, doors opening by foot devices instead of handles)?

3. What important facts concerning disease transfer are not generally known in your community? Suggest ways of presenting them to insure full recognition of their importance.

4. Write a popular article designed to interest a special group of people in protection against one disease; *e.g.*, school children against common colds, or against transfer of dysentery by cooks and waiters.

5. New York City has a law demanding that waiters and food handlers (hotels, restaurants, push carts) be examined yearly to show that they are free from tuberculosis, typhoid and syphilis. Has your city such a law? How could such a law be secured for your city?

6. Would the following rhyme make more impression than a prose statement? Use this same treatment for a similar situation.

"Mary had a little cold
That started in her head,
And everywhere that Mary went
That cold was sure to spread.

"It followed her to school one day,
There wasn't any rule;
It made the children cough and sneeze
To have that cold in school.

"The teacher tried to drive it out,
She tried hard, but, ker-choo!
It didn't do a bit of good,
For teacher caught it, too."

7. Many people take off their rings and hold them in the mouth while washing their soiled hands. Criticise.

8. Waving the handkerchief is a form of salute often used in public demonstrations or gatherings. Explain why it may be dangerous.

9. Show why people who "bite and spread" as they eat a piece of bread should be careful to avoid putting their knives back into the common butter dish.

10. It has been well said that most of the observances called "good manners" have hygienic significance, *e.g.*, covering the mouth when coughing. How many other instances can you find?

See Reference List at end of Appendix.

CHAPTER X

DISINFECTION AND QUARANTINE

CENTURIES ago we find observation of quarantine periods. In India, houses of the dead might not be entered for varying periods after certain diseases, commonly three to fourteen days. A forty-day seclusion was demanded for plague. The word quarantine is an Italian word (*quarante,* forty) and dates back to the middle ages when Venice and other Italian cities detained vessels with plague aboard forty days.

Federal Quarantine.—Ships entering our country from foreign ports are required to bring a Bill of Health from our own consul at the port of departure. This contains such necessary details as the number in the crew, number of passengers, source of the ballast (usually water; often sand containing street sweepings, etc.), and deaths at the port of departure from the six quarantine diseases for two weeks preceding the date of sailing. Besides this, the ship must present at port of entry a list of all illnesses since sailing, present all passengers and crew for inspection, allow the ship and cargo to be inspected; disinfect such articles as are open to suspicion (*e.g.*, hides, hair, fur, which often bring in anthrax).

The federal government has interstate quarantine power for some twenty diseases (p. 183); typhus, yellow fever, plague, smallpox, cholera, leprosy are the ones for which incoming vessels are quarantined (maritime quarantine). A few States have interstate agreements regarding typhoid fever, tuberculosis, measles, foot-and-mouth disease, but more definite control is needed, and, as recommended elsewhere, federal control would do much to unify and support satisfactory State control.

Quarantined boats and buildings are usually disinfected after the patients have recovered, or have been removed to hospitals, etc., and then quarantined for the known incubation period of the disease, five to fourteen days. Instead of simply waiting for the organism to die as in the old idea of quarantine, disinfection is resorted to, to kill off most or all of the organisms on the furniture.

bedding, etc. This decreases the detention period to the time necessary for new cases to develop.

Isolation.—Individual quarantine or isolation is a slightly different matter. In certain diseases the patient may become a carrier, thus prolonging the necessary period of isolation. In all such conditions isolation must continue until the patient is no longer discharging virulent (G) organisms. Isolation of stricken individuals is not a complete safeguard in all cases. In measles, for example, for about three days preceding the usual recognition of the disease the nasal discharges are very infectious. Isolation should be adopted as soon as a communicable disease is recognized, to prevent further infection of the well. To safeguard against this, it is becoming customary to demand microscopic evidence in the diseases in which present knowledge renders it possible; for example, in diphtheria city departments of health often demand that the microscopic examination of sputum be negative (diphtheria bacilli absent) in three consecutive examinations before the patient is released from quarantine.

House Quarantine.—It is now recognized that the complete quarantine formerly thought necessary may be modified in certain diseases without harm to the rest of the community. Rosenau says quarantine must be a sieve or filter, not a dam; that it must be enforced with the least hindrance to trade and travel. It must also consider the health of the infected individual and partial freedom should be allowed whenever possible. In some cases, such as whooping cough, it is possible to allow considerable freedom (motoring, walking on street with responsible attendants) if the patients are careful to avoid close contact with others, avoiding street-cars, shops, etc., and all susceptible individuals, such as other children.

In yellow fever it is sufficient to keep the patient in a completely screened room, as the organisms causing yellow fever can only leave his body or enter the body of another through mosquito bites. (It is, of course, necessary to make sure that no mosquitoes are also screened in—and that occupants of the house do not carry mosquitoes in with them.)

Unfortunately, public sentiment does not yet wholly support quarantine, and the restrictions are too often looked upon as something to avoid. In some communities a guard may be necessary to

secure protection for the rest of the community. The greater dependence upon hospitals, the more general tendency to call for the services of a private trained nurse, or the aid of visiting nurses, and the gradual education of the people through the schools (school nurse, enforced absence for evident infection) are all having effect.

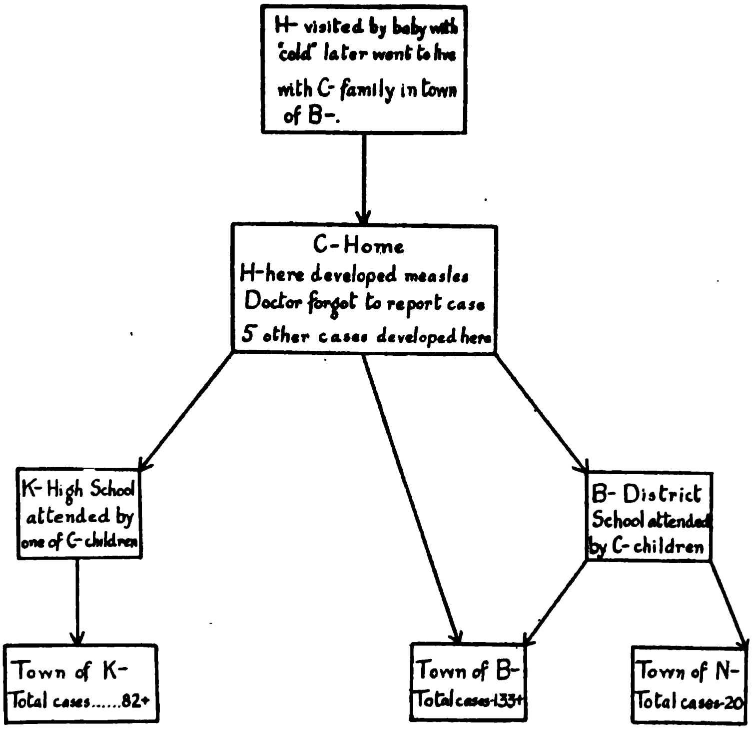

FIG. 47.—A case of measles in which the doctor "forgot" to file the card reporting the disease. This resulted in over 270 cases of measles in three adjoining towns in New York State (including several unreported cases). (Based on data in Health News, N. Y.)

Quarantine will always miss a few cases—non-typical ones, or cases so slight that the disease is not properly diagnosed; healthy carriers may transfer organisms wholly unsuspected for years, especially if there are a number of immune people in his contact groups. In such conditions, new cases may continue to develop even with strict isolation of known cases. This, of course, is not an argument against quarantine, as the number of cases would doubtless be still

greater if no quarantine were enforced. Every effort should be made to make this clear to the members of the community.

There is still, however, great need for public education concerning the necessity for quarantine or isolation of the sick, because most sick persons are cared for at home by untrained people; but a very small per cent. of ordinary communicable illnesses are cared

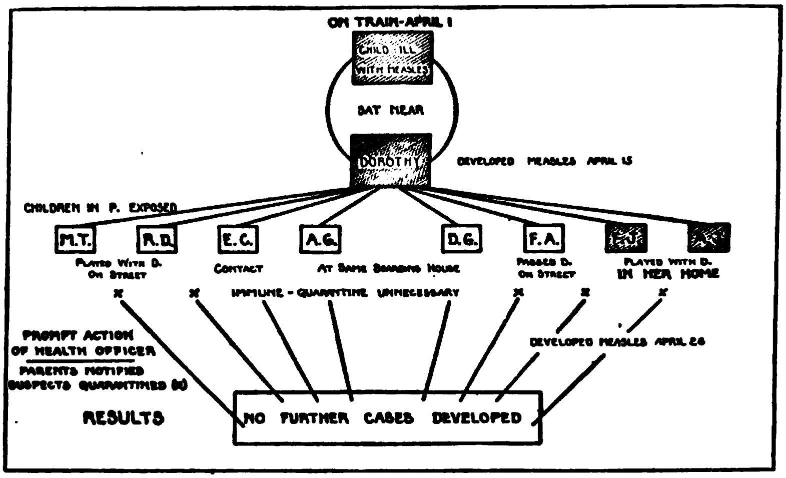

FIG. 48.—When Dorothy developed measles her mother recalled a train companion of a few days before from whom she had evidently contracted measles. The health officer was notified and he at once quarantined all marked X, thus checking the spread of the disease.

for in hospitals or by fully trained nurses. The proofs of the value of quarantine are all negative ones, and it is hard to make people realize that "every case isolated is a focus neutralized." That is illustrated by the accompanying diagram showing the effects of isolation and non-isolation of cases of measles (Figs. 47 and 48).

The main problems in quarantine are probably (1) those concerning children (Fig. 49), and the overcoming of the idea that "it's better to have it and be done with it," and (2) our own responsibility for foregoing pleasure or business when affected with colds, sore throat, etc. As long as laws do not *demand* such self-isolation, few are public spirited enough to demand it of themselves.

School Regulations.—The fold-in chart opposite page 186 (Fig. 49), is taken from *Health News* and gives detailed regulations for children's diseases.

A committee of medical advisers of several private schools in New York City issues little cards like the following, which must be presented when the child returns to school. A different color is used for each of the common communicable diseases. The face of the card is used for the attending physician's certificate and the back of the card for information relating to the disease.

Disinfection.—A few years ago our largest cities were spending large sums of money for compulsory disinfection, which was required after most communicable diseases, *e.g.,* diphtheria and scarlet fever.

The whole theory of disinfection has undergone decided changes in the last few years, however. Experiments have shown that organisms in the air tend to die off rather quickly under ordinary conditions (see chapter on Air, Chapter VI, p. 115). Then, too, it was found possible to care for two or three different communicable diseases in the *same* room without cross transfer, *if* the attendants were particular about washing their hands after attending a patient, and before going to the next patient. The hospital at Providence was the first to demonstrate this principle on a large scale. The various patients may be separated merely by low partitions; and if opportunities for washing the hands are arranged for each cubicle or compartment, the cases of cross transfer may be less than in some hospitals using separate wards for the various diseases. This indicates that the organisms do not live long enough in ordinary air to make the necessary circuit (over partitions, etc.), but that the greatest danger lies in direct contact.

Such facts as these have led us to change our former rulings concerning disinfection. It is evident that organisms discharged by a patient would not live on floors, carpets, walls, etc., as long as they would continue to live in his body. By the time the convalescent period is over, relatively few of the organisms discharged during the course of the illness are still alive. In other words, by the time the patient himself is a safe companion, the room and its contents are not very dangerous, especially if the patient's discharges have been cared for properly.

Concurrent Disinfection.—That means that we must have *concurrent* as well as *terminal* disinfection. It is not, as some people think, that disinfection is no longer necessary; it is rather that continuous disinfection is added to terminal disinfection. We

Condition	Disinfectant or disinfecting process	Remarks
Cuts or breaks in skin	Iodine, alcohol	Then wrap in dry sterile gauze. Alcohol is too drying to repeat often. Once a day is enough for iodine. If wounds are re-infected (dirty water, etc.) use disinfectant again—even at risk of too great drying
Wounds containing pus	Hydrogen peroxide. Flush until pus is washed out	
Chronic sore throat, sore eyes	Silver nitrate	To be used only by experienced nurses and doctors
Inflamed or blood-shot eyes	Boric acid (sat. solution)	Good antiseptic; harmless. Use fresh cups, etc., for each eye
Sore throat	Argyrol (15 per cent.) or tincture of iron by brush. Gargle hydrogen peroxide (½ water)	Argyrol is much milder; iron solutions should not come in contact with the teeth
Tooth brushes	Drying and sunlight. Salt—dry on tooth brushes [1]	At least 2 tooth brushes should be kept in use—to insure thorough drying. Wet, soggy tooth brushes should not be tolerated
Sponge cups, envelope moisteners	Thymol 1 : 1000	Can be made inexpensively at home in large quantities. An antiseptic only. Hands that handle money should be washed thoroughly in *soap* before eating
Hands	Scrub with green soap and hot running water	
Drinking water	Boiling	See appendix for chemical treatment
Swimming pool	Hypochlorites	See appendix
Room and contents	Formalin	See appendix
Woodwork and floors	Strong hot soapy water; 1 half-pound cake to 5 quarts of water	Follow by hot soapless water, if surfaces are affected by soap

[1] This dried salt should be washed off before using. Too much salt may irritate the gums. A cup of salt in which the brush can be twisted around to secure a thorough coating on the bristles will be found convenient.

Condition	Disinfectant or disinfecting process	Remarks
Boats, cars	Formalin (or hot steam for hulls, etc.)	See Appendix
Stables	....	See reference in Appendix
Infected bedding, towels, handkerchiefs	Boil in strong soapy water	To be sure all the water is equally hot, boil 20 minutes to 1 hour. Disinfectants may be added but are not necessary. If disinfectants only are used, use one with label giving *definitely* its strength when compared with carbolic acid
Mattresses, rugs, carpets	Sun 2-3 hours on each side	Spread on grass or hang on line to expose fully
Hired or borrowed clothes	Sun as above, especially surfaces in contact with the body	Formalin may be used if opportunity for sunning is lacking (see appendix)

acid—a favorite disinfectant of firmly established value, because it does not affect fabrics, even dyed goods, and acts directly upon bacteria, even spores, no matter if much other organic matter is present—is no longer possible as a disinfectant. Its price is nearly a dozen times its pre-war price of eighteen cents a pound; then, too, patriotism demands that we find a substitute, as carbolic acid is needed in making munitions. Many acids are so destructive to textiles, metals, etc., that they cannot be used at all.

Argyrol and hydrogen peroxide are two very valuable aids, but spoil very rapidly and often give a false feeling of security, especially argyrol which gives no characteristic sensation by which one can judge of its strength.

See p. 189 for a list of the common uses for which one may require a disinfectant. Many other disinfectants could be given, but the preference has been given to common substances obtainable at most drug stores, except for a few so widely known or by such well-known firms that they, too, can be easily secured.

Home and Emergency Disinfectants.—In general, avoid for home use the disinfectants known to be poisonous. The risks are too great. If they are to be used, have the druggist add to such colorless poisons as corrosive sublimate a little coloring (such as

methylene blue or any other aniline dye). There is no reason why poisonous tablets should not, when manufactured, be slightly tinted with a bit of aniline dye to prevent their being taken as headache tablets.

Some disinfectants are valuable for emergencies—or for occasional use, but should not be used repeatedly. Gasoline is a disinfectant usually available in automobile accidents; turpentine is another often used by workmen, but both are too irritating to use if better disinfectants can be secured. Alcohol kills most human-disease bacteria in one minute. It is useful as a first wash on cuts or bruises; but it dries the wound if used repeatedly and makes it crack or heal very slowly.

Patented Disinfectants.—If patented disinfectants are used, see that they bear the name of a well-known firm, or else ask your local or State health board what their value is. There are on the market many tooth washes of no disinfecting value whatever. The buyer can to a great extent protect himself by a careful reading of the label. Reputable firms do not care to risk their reputation by exaggerating the values of their disinfectants, so their word can usually be relied upon. They have expert chemists who determine exactly how strong a disinfectant is and their products state it plainly and positively in one of two ways: (1) by comparing it with the well-known standard, carbolic acid (phenol), saying it is two times as strong, can be used one-fifth as strong, etc. If a preparation such as lysol is more efficient than carbolic, they indicate its increased efficiency as just described, or say it has a coefficient of 3 or 6. (2) The second way is by saying clearly it will kill such and such bacteria, mentioning them by name, and giving the time necessary. Cheap or unreliable firms often advertise Germicide or Bactericide in big letters, but to avoid prosecution do not support it in either of these two ways in the descriptive matter on the bottle. Sometimes the wrapper says "Germicide," but the bottle label merely says "safe mouth wash," or "antiseptic for wounds." A firm that hesitates to state clearly what the actual strength is, either does not know—or does not want you to know. In all such cases take the simpler unpatented articles, such as alcohol.

Firms often advertise in concrete (but vague) ways to catch the public eye. "Do you want to avoid Riggs disease? Then use No-Rigg tooth paste." Or, "Put a little No-Germ in the waterbox of

your furnace and avoid disease." When bacteria are put into strong solutions of No-Rigg paste or No-Germ they are not killed. The advertisements in question are purposely misleading. If No-Germ cannot kill bacteria placed directly in it, how could it kill bacteria in the air in the house when a little is put into the waterbox of the furnace?

Heat as an Aid.—Heat increases the value of any disinfectant, therefore weak disinfectants, such as borax or salt, are more effective as a gargle if used in hot water. (Inflammable substances, like alcohol, should never be heated over or near a flame.)

Soaps.—Soap as a house disinfectant should be used in strong solution, 10 per cent. (one-half pound to five quarts of water), and the water should be as hot as possible.

Green soap,[2] so frequently used, seems quite valuable as a hand disinfectant. The hands are scrubbed with full-strength green soap for five minutes. Its proportions are given, as its effect upon the skin also tends to make it popular.

Medicated Soaps.—There is some danger in using common soaps in public places, especially where the users follow in close succession. Liquid soap containers should be provided in all public lavatories (including boarding houses); these lessen the chance of contact with injurious bacteria, for some may live long enough on cakes of soap to be transferred to other people. The small amount of any chemical added to soap is usually insufficient to affect bacteria. Take carbolic soap as an illustration. A 5 per cent. solution of carbolic acid kills bacteria in twenty to thirty minutes. No one pretends to believe that any soap lather or soapy water contains 5 per cent. of carbolic acid, and we do not wash our hands for twenty to thirty minutes at a time. Some disinfectants have a cleansing action, helping to remove grime, to cut grease, etc. The common commercial soaps are not dependable as hand or skin disinfectants. Rosenau says the ordinary medicated soap is usually a snare and a delusion, and states that carbolic acid, bichloride of mercury and many similar substances may so combine with the soap as to *decrease* their slight disinfecting power.

Exception might be made to McClintock's soap, which contains

[2] Green soap: 10.2 per cent. potash soap, 0.8 per cent. olive oil, 1 per cent. glycerin, 43 per cent. alcohol and 45 per cent. water.

an unchanged active mercury salt, and a 1 per cent. solution of this soap kills typhoid, diphtheria, etc., in one minute. It has the added advantage of not attacking ordinary metals or instruments.

The treatment of wounds is discussed under Military Hygiene (p. 342).

PROBLEMS

1. Give for some communicable disease a route of transfer which has come under your observation.

2. Give from your own experience a blocked route of transfer, such as that shown in Fig. 48, in which only children exposed to Dorothy contracted the disease. Show that the attitude of parents with regard to diseases—even children's diseases—makes them valuable or objectionable members of a community, no matter what their other qualifications may be.

3. What diseases are subject to quarantine in your locality?

4. Recently, in a girl's dormitory, a senior isolated with acute sore throat broke her parole and visited two friends, both of whom later contracted a sore throat. For what besides their doctor's bill should the first girl have been held responsible?

5. Write out a set of directions for the concurrent disinfection of typhoid.

6. Write out a set of directions for terminal disinfection of a room occupied by a tuberculosis case; number the directions in order of their proper sequence.

7. Send for Reprint 436, Public Health Service. This gives for 38 communicable diseases the infective agent, source of infection, mode of transmission, incubation period, period of communicability, and methods of control. What use can be made of this valuable pamphlet by heads of families? By school authorities? By health departments?

See Reference List at end of Appendix.

CHAPTER XI

TREATMENT AND PREVENTION OF DISEASE

THE BODY REACTIONS

One of our pioneer bacteriologists has said, "We never really cure any disease; we only help the body to overcome it." The nearest we can come to a definite exception to this statement is the action of certain chemicals, such as quinine for malaria, which, injected into the blood, destroys the malaria organisms. But it would be difficult even in this case to prove that the chemicals did everything and the body cells nothing.

Body Reactions to Disease.—It is, therefore, necessary to understand just how the body reacts against disease-producing organisms, if we desire to increase these reactions in treating those ill of disease, or to prevent others from contracting given diseases.

A person who recovers from a disease, such as tuberculosis or diphtheria, does so because one or both of the following reactions have occurred: (1) his white corpuscles have destroyed the invading organisms; or (2) in his blood have accumulated definite substances called antibodies, which are antagonistic to the invading organisms. Antibodies act *against* these foreign bodies or organisms; therefore the term antibodies. These substances are not definite bodies like the white corpuscles and cannot be seen even with a microscope. They are contained in the liquid part of the blood, and while they cannot be shown to be present even by the microscope, or by chemical tests, they are very powerful aids in overcoming disease. They may kill the bacteria or they may help the white corpuscles destroy the bacteria. All these reactions are summarized in the following diagram:

Body reactions to disease	Increase in white corpuscles (phagocytes).	
	Formation of antibodies which	Dissolve bacteria (lysins).
		Aid the white corpuscles (opsonins, agglutinins, precipitins).
		Neutralize the bacterial poisons (antitoxins).

Lysins.—The lysins or antibodies that dissolve or destroy bacteria may be very powerful, destroying large numbers of bacteria in

a very short time. How remarkable their power is may be surmised by what they can do under circumstances where this bactericidal action can be definitely measured. An early experimenter, Nuttall, mixed a little rabbit's blood with some live anthrax bacteria and counted the number of bacteria in a drop of that mixture. Four minutes later he counted the bacteria in another drop of the mixture and found 53,000 less bacteria than before. Although rabbit's blood is remarkably active against anthrax organisms, the

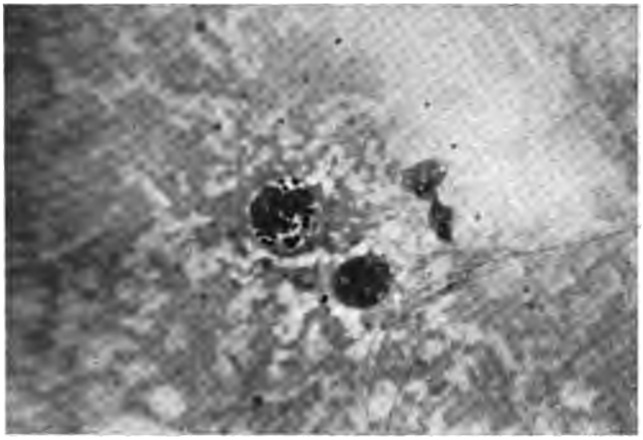

FIG. 50.—In the centre is a large white corpuscle which has ingested or swallowed pneumonia organisms.

results are none the less wonderful. It is thought, too, that such reactions are much greater in the body itself than when the blood is taken out into test tubes for such tests.

Since blood (or lymph, which is practically blood—lacking the red corpuscles) is in contact with one or more surfaces of all living cells, it is easy to see how effectively such antibodies may protect the body.

Action of White Corpuscles.—Other antibodies in the preceding diagram were classified as aiding the white corpuscles. White corpuscles alone are not very active destructive agents. While white corpuscles without the aid of these special substances found in the blood-serum (G) may take in bacteria (Fig. 50), this

"simple engulfing of bacteria is not necessarily a destructive process." If these special substances or antibodies are present in the blood-serum, they increase the rate at which the corpuscles take in and destroy bacteria (phagocytosis).

All this can be demonstrated by the microscope. If white corpuscles and tuberculosis bacteria are mixed together, the corpuscles will take in a certain number of bacteria (Fig. 50). If a little serum is added to the mixture, the white corpuscles show decidedly greater power; not only do they engulf the bacteria more readily, but they destroy larger numbers of those engulfed. If the serum added is that of a person who has recovered or is recovering from tuberculosis, the white corpuscles show still greater power, because that person had evidently accumulated a large amount of these special antibodies which affect the bacteria, and prepare them for the white corpuscle action. Such substances are called opsonins.[1]

More is heard about the opsonins in connection with tuberculosis than in any other disease. It was at one time hoped that we could tell the patient's condition and progress by determining from time to time the number of bacteria taken up by white corpuscles when his serum was added, as described above, measuring the opsonic power of his blood serum. But it is so difficult to measure accurately the amount of opsonin present that little is now attempted along that line. It is important to realize, however, that this does *not* mean that the opsonins are thought to be unimportant aids. On the contrary, the phagocytic action of the white corpuscles depends upon these antisubstances.

Agglutinins.—Sometimes the antibodies which aid the white corpuscles may be even more strikingly demonstrated by means of the microscope. If the serum of a person who has had typhoid fever be added to a drop of living typhoid organisms, these actively motile bacteria slow their movement and finally come to rest sticking together in groups or clumps, often several dozen in a clump (see p. 215 and Figs. 60 and 61). This clumping is just what would result if they had become sticky or glutinous, and we therefore say they have agglutinated.

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[1] Like opsonium, a little-used word from the Greek, which is used for anything eaten as a relish, such as olives or anchovies. The term opsonins, therefore, implies that these substances are like relishes, making the bacteria more attractive to the white corpuscles.

It has recently been shown that this same clumping or agglutination takes place in the body as well as in drops of serum observed under the microscope. Such clumping is the result of a protective antibody formed by the body against the bacteria, and favors their destruction by the white corpuscles (Fig. 51). It suggests the old recipe for cooking hares, which began: "First catch your hare," for these clumped or agglutinated bacteria are more easily caught and engulfed by the white corpuscles. Motile bacteria lose

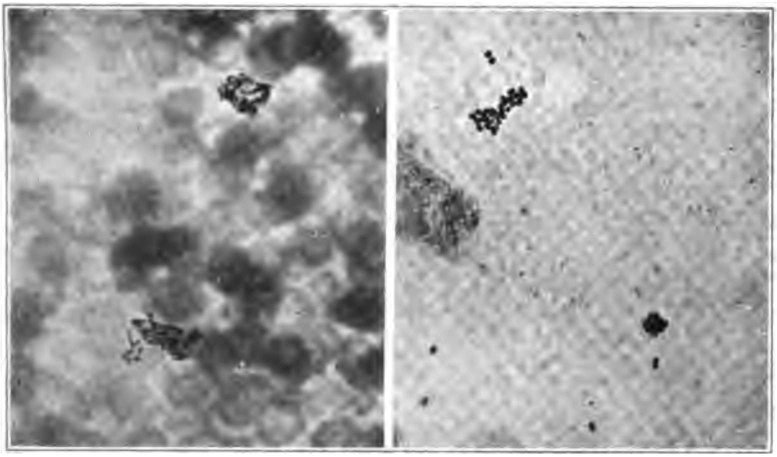


FIG. 51.—A rabbit made immune to typhoid by earlier injections of *Bacillus typhosus* was later given a heavy injection of the same organism. The left photograph of blood taken from the heart 30 seconds later shows clumps of bacilli and indicates how rapidly agglutination took place. The agglutinated cocci (right photograph) were from a rabbit immunized against pneumococcus (causal organism of pneumonia, and injected similarly with pneumococci).

their power of movement; the large clumps stick to the walls of the blood-vessels, or are delayed in the smaller capillaries; they are held back in such glands as the lymph "nodes" (G), and so are more promptly disposed of by the white corpuscles.

It has been suspected for some time that this agglutination was one of the aids against bacterial invasion, but it was not supported by proof until Bull showed that this agglutination is a very prompt reaction of the body, and that the bacteria are agglutinated, engulfed by white corpuscles, and destroyed in a very short time, so short a time that it had therefore been missed entirely by other

investigators. If live typhoid bacteria are injected into the blood of an animal which has had typhoid fever, blood drawn one to two minutes later from the heart or other organs will be found to contain agglutinated clumps of bacteria and white corpuscles which are already gorged with bacteria, often dozens in a single white corpuscle. The reason this agglutination was not observed by earlier investigators in such experiments was that they looked too late, after the bacteria had been agglutinated and the white corpuscles had already destroyed most of them. Another surprising thing is the strength of this antibody, the agglutinin. A horse injected with typhoid bacteria, until he has become immune to typhoid, may accumulate a very powerful agglutinin. An agglutinin recently tested at Rockefeller Institute was so strong that one drop of such horse blood agglutinated many billions of typhoid bacteria, all that could be grown on four agar tubes.

In some cases these agglutinating substances work in such a way that the collected clumps of bacteria are large enough to be seen with the naked eye. If a horse has glanders, his blood-serum contains substances which will clump or agglutinate glanders bacteria when they are added to the horse's serum in a test tube. The clumped bacteria are gathered together into a little rounded ball in the bottom of the test tube, not at all in the way gravity would cause them to settle. Usually, too, the rate at which they are so precipitated is very much quicker than in the case of gravity. It is thought that these precipitating substances are really the same as the agglutinins, and that they act in the same way in the body, but differ only in that they are demonstrated better in test tubes than by the microscope.

Antitoxins.—The antitoxins are another very important class of antibodies. They differ from all we have discussed in that they do not affect the bacteria directly, but simply neutralize the poisons (toxins) which the bacteria make; therefore, antitoxins. In a few diseases, such as diphtheria, antitoxins are the most important aids in overcoming the disease. Even when the bacteria are quite localized and not distributed generally through the body, the toxins formed by the bacteria may be rapidly distributed to all parts of the body. For example, in diphtheria (Fig. 7), the organisms are usually located in small patches in the throat, but the poisons these bacteria make are absorbed by the blood and distributed to all parts

of the body; and we have as a result general irritation and disturbance of many different parts of the body: headache, backache, nausea, fever, as well as the sore throat one would naturally expect. If a person is to recover from diphtheria, he must not only kill off the diphtheria organisms in his body, but he must also neutralize or make ineffective the poisons they have formed. Antitoxins are the most important protective agents or antibodies against diphtheria and tetanus (lockjaw) and probably against the gas gangrene bacillus also.

It is not thought that any one of the antibodies works singly or exclusively in any disease. The serum contains more than one antibody, usually; for example, while antitoxin is the most helpful agent in aiding against diphtheria, the serum has at the same time some bactericidal power, and the white corpuscles are also helping to destroy the organisms. One of the hottest arguments in the history of bacteriology was about the relative importance of these protective substances. Metchnikoff, working on tuberculosis, where phagocytosis is the most important protective factor, claimed that recovery from disease was due to the action of white corpuscles. Behring, working on diphtheria, claimed that recovery was due to the action of the antitoxin. Each worker verified his own findings, Metchnikoff for tuberculosis, and Behring for diphtheria, and presented still stronger arguments for his own side. If each had worked with the other's material, he would have seen at once that the other was also right. It was another case of the two knights and the two sides of the shield.

Immunity Following Disease.—The antibodies which are formed by our bodies to protect us against invading bacteria are usually produced in excess of what is actually necessary, and so they may be found in the body a long time after the bacteria have all disappeared. This is illustrated by the following diagram (Fig. 52).

The organisms causing a given disease enter the body and begin to develop at the time represented by *a*. The body reaction begins a short time afterward, at *b*. The multiplication of the bacteria, and the increase in antisubstances are represented by the rising lines *a-c* and *b-d* respectively. These two processes run a race, as it were, and finally at *c* the antisubstances begin to be found in excess, and this overproduction continues for a time to *d;* but from *c* the bacteria have been decreasing and, finally, there comes a time,

e, when there are none of them left in the body. The antisubstances, however, may persist for some time: weeks, years, or throughout life. They usually persist a long time after smallpox, but a very short time after common colds, etc. The time from *e* to *f* represents the time between the end of one attack and the point at which the individual might come down with another attack of the same disease. In other words, *e* to *f* represents the immune period following the recovery from a given disease.

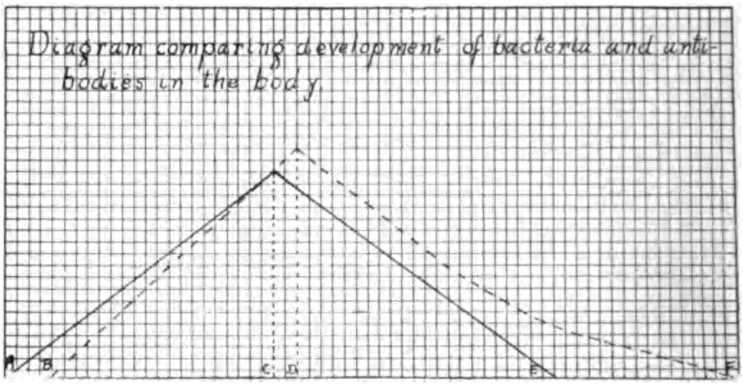


FIG. 52.—Diagram with a black line representing the development of bacteria in disease, and a broken line representing the formation of protective substances (white corpuscles, antibodies). A to B represents the incubation period; E to F represents the immune period following recovery. (See p. 199).

"**Natural Immunity.**"—Sometimes a person's blood contains some of these antisubstances or immune bodies, even though there is no record of his having had the diseases in question. We sometimes speak of these people as naturally immune; that may be the correct explanation, but it is very possible many of these "naturally immune" people have really had an earlier attack of disease. There are so many cases that are difficult to diagnose—non-typical cases—as well as so many slight cases which may not demand the services of a physician, that we can never be sure how many of these naturally immune people are really "missed cases."

In a few cases it is quite possible that "natural immunity" may be related to the illness of the mother a short time before the birth of the child; in such cases the child may have had the disease

at the same time, or antibodies in the blood of the mother may have been transferred to the child.

Other Types of Immunity.—Other types of immunity have been described, such as racial and age immunities; negroes seem less susceptible to yellow fever, children are more susceptible to whooping cough, measles, or scarlet fever than adults (Fig. 53). Sometimes racial immunity resolves itself into tolerance, and people who think themselves immune to malaria are sometimes surprised when the organisms are shown to be present in their blood. This means that they are not really immune to the disease in question,

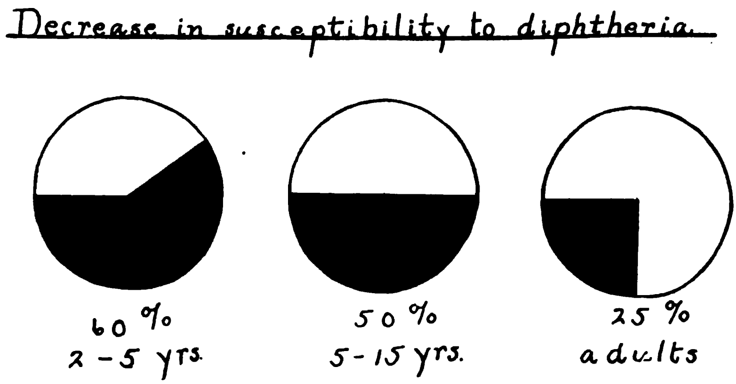


FIG. 53.—Diagram showing relative susceptibility of children and adults to diphtheria. (From data in Health News)

but that they can tolerate the organisms. The relative immunity of adults is often traced to "missed" or forgotten cases in childhood; children, too, come into closer contact with each other and are less particular about handling things in a sanitary way, which also helps account for the so-called partial "immunity of adults" to children's diseases: so that all statements regarding immunity must be weighed carefully before acceptance. Racial or other predisposition to disease often resolves itself into increased opportunities for infection, lessened resistance because of unsanitary homes or insufficient food, etc.

Predisposing Factors.—Hunger, worry, alcoholic excess, overwork, and overexposure are predisposing factors to disease; for ex-

ample, chickens are quite immune to tetanus, but it has been shown by experiment that if a chicken is chilled, it succumbs to the inoculation of a small amount that otherwise would not affect it.

TREATMENT AND PREVENTION

In the preceding paragraphs we have spoken as if recovery always followed an attack of any disease—as if the white corpuscles and the antibodies always increased at a sufficiently rapid rate to prevent a deadly accumulation of bacteria and their toxins. Unfortunately, this is not true, and bacteria and their irritating products often multiply much more rapidly than the body can provide protection by the formation of extra white corpuscles, antitoxins, agglutinins, etc.

If, in our diagram, the line *b-d* never crossed the line *a-c*, the bacteria would continue to multiply indefinitely, and death would finally ensue. The length and severity of the illness would depend upon how nearly the reaction or antibody line approached and followed the bacteria line.

Chronic cases belong here; their body reactions always lagging behind what is necessary to destroy all the bacteria.

Methods of Aiding the Individual.—It is now known that it is possible to help the individuals who are too slow in forming these protecting substances. We can do it in three different ways: (1) by giving them drugs or chemical agents which will kill the bacteria; (2) by stimulating the body cells to form the antisubstances more abundantly; and (3) by giving the individual antisubstances made in the body of another animal. We will discuss these three methods separately.

Chemical Agents.—We are somewhat limited in the means we can employ in the first way, for while there are many chemical agents which could be used to kill the bacteria, there are not many that could be used in sufficient strength without destroying the surrounding tissues or irritating them so that they do not heal properly. For example, strong acids cannot be used to disinfect wounds; and while such irritating chemicals as carbolic acid and turpentine are sometimes used, they are used very sparingly or in very weak dilutions. Radium is another chemical agent which has serious attending dangers, as shown by the "radium burns" experienced by doctors and radium handlers. These "burns" often refuse to heal,

even with the best treatment science affords. It is, therefore, conceivable that the radium treatment of diseased tissue (*e.g.*, cancer) might injure the body cells before it affected the cause of the disease. Below are listed the diseases most commonly treated by drugs or chemicals:

Disease	Drug or chemical	Remarks
Malaria	Quinine	
Syphilis	"Salvarsan"	A trade name for an arsenic-benzol compound. Other related drugs are in use for advanced or severe cases
Wounds	Aniline dyes (gentian violet, methylene blue)	See table p. 189 for iodine, alcohol, and other chemicals

Stimulating Body Reactions by Killed Organisms.—There are several ways of stimulating the body cells to form protective antibodies; these methods are all alike in that they use disease organisms which are greatly weakened or killed before they are injected into the human body. In typhoid, for example, a known amount of killed typhoid bacteria is injected into the flesh, usually about 1 or 2 c.c., containing usually one-half to two billion bacteria. These bacterial substances are absorbed by the blood, and stimulate the formation of the same antibodies as would typhoid entering the body in food, water, etc. Usually three such injections are given (at intervals of a few days) to make sure that the individual forms enough antibodies to last for some time, usually two to three years at least. Recently, in the United States army a special glycerin combination of three disease organisms has been given, all in one injection, and with good results (see table, p. 211).

Live organisms have been advocated for typhoid protection, but since typhoid may persist in the intestine and make people "typhoid carriers," this seems a very unwise procedure.

Protection by Weakened Organisms.—The earliest use of weakened organisms to prevent disease was in connection with smallpox, which was formerly very common; as late as 1750-1780, in England, France and Italy, less than ten people in every hundred escaped smallpox. Lady Mary Wortley Montagu, in 1718,

introduced into England, after trial in her own family, a method she found in practice in Turkey. Pus from an eruption on a "light case" was inoculated into the blood of a person who had not had smallpox, thus making it quite probable (though not at all certain) that the inoculated person would have a similarly light case. This practice was quite generally adopted in the United States as well as England, and as late as our own Civil War was used to prevent smallpox. The people of Richmond, by a house-to-house canvass, were besought to have their children inoculated; the scabs were collected and used to inoculate soldiers in the Confederate army.

A better method of securing weaker smallpox organisms was even at that time in use in England. Jesty, a farmer, and Jenner, a physician, knowing the belief of dairy workers that people who had cowpox did not take smallpox, performed experiments which proved the accuracy of such beliefs. Jesty inoculated his wife and two children with cowpox successfully. Jenner tested more directly whether cowpox could protect against smallpox by inoculating with smallpox pus ten people who had had cowpox. Not one contracted smallpox, though twenty to fifty years had passed since five of the number had had cowpox. Jenner added one more experiment, inoculating a boy with pus from a dairymaid who, through a cut in her hand, had contracted cowpox from a cow she milked. This cow pus "took"; twice afterward Jenner inoculated the boy with smallpox pus, but the boy was immune. The material taken from the cow was called vaccine (*vacca,* a cow), and the process, vaccination. Inoculation of smallpox pus from human beings soon decreased as vaccination was very much safer, and gave a much milder form of the disease, because the organisms of smallpox had been weakened by their period of growth in the cow.[2] About forty years afterward (1840) the newer method had so gained in favor, that the English government forbade immunizing people by smallpox pus.

Other Methods of Attenuating Organisms.—Organisms that cause disease may be attenuated or weakened in other ways besides growing them in less susceptible animals. If bacteria are grown in

[2] There is little doubt that cowpox is really a form of smallpox contracted by cows from human beings.

the presence of weak chemicals, subjected to too high or too low a temperature, dried, or simply allowed to grow old, they may become similarly attenuated. Pasteur used drying to attenuate the rabies organisms which are found in the brain and spinal cord of rabies animals. The methods generally used to-day are practically his methods. The spinal cord of a rabid animal is cut into little segments, and the pieces dried to various degrees of dryness. The pieces dried longest contain, of course, the weakest organisms. The weakest segments are ground up into a fine emulsion and injected into the body of the person who has been bitten. His body cells react to those weak organisms, forming the necessary antibodies. This is repeated with stronger and stronger organisms (cord segments dried for shorter periods of time), until almost full strength of organisms is given—dried for but three days, or even but one day.

Rabies organisms develop slowly; the repeated injections of organisms of increasing virulence call forth greater and greater numbers of antibodies, until the body is fully protected against all the results that could have come from the organisms left in the body when bitten by the dog. It is interesting to know Pasteur tried this treatment on fifty dogs with success, but even then could not by the laws of France try it on a human being. Finally he was allowed to treat an unfortunate individual for whom there seemed no hope, as he was badly bitten—in fourteen places—and vindicated his theory.

The Term "Vaccine."—The term vaccine, as we have seen, was first used for live but weakened organisms obtained from a living animal, the cow. Most vaccines, as the term is now used, are not produced in living animals at all, but are grown in tubes or flasks of broth in the laboratory; in treatment, some of these broth growths or cultures are weakened by chemicals, unfavorable temperatures, etc., but most of them are actually killed before they are used.

Killed Organisms.—For vaccines made of these killed bacteria, some authorities use the word *bacterin,* reserving *vaccine* for living organisms. This distinction, however, is not generally made, and the use of the term *vaccine* for the killed cultures so widely used in this present war will make it impossible ever to restrict the word vaccine to its original meaning.

The bacteria used in making all vaccines are taken originally

from diseased tissues and kept alive on broth, gelatin, etc. Sometimes they lose their virulence in long-continued cultivation on artificial media, but that does not always happen; for instance, the diphtheria bacteria now in use in almost all parts of the world for making antitoxins was isolated years ago by the New York City Board of Health, and it seems even more virulent than when originally isolated.

There are various types or varieties of most disease organisms. The vaccine provided by any laboratory is often not made from the special variety infecting a given individual, and, therefore, not quite so helpful to him as if made from his own particular type. It can be secured by taking material (blood, pus, etc.) from the infected area and getting from it the organism responsible for the trouble. This organism may then be grown in broth, etc., and used as a vaccine. Such vaccines are called *autogenous vaccines*. In serious or quickly-developing illnesses there is not time to wait for the making of autogenous vaccines, as it takes at least two to four days; but it is often done in treating slow or chronic diseases, such as persistent boils, especially if the patient does not respond to the types of vaccine in general use.

Dosage.—The dosage varies greatly, depending upon the physician's diagnosis, the period through which the doses are given, etc. The following figures indicate the wide range: typhoid, 2 million to 10 billion; influenza, 10 to 500 million; streptococcus, 5 to 500 million; staphylococcus (for boils, etc.), 100 to 1000 million.

Antitoxins.—Some bacteria make large amounts of toxins which, being soluble, are found in the broth in which the bacteria are grown. If this broth is filtered, the material passing through the filter (the filtrate) contains these soluble toxins. If this toxin-containing filtrate is inoculated, the person or animal reacts, forming antibodies about as he would if the bacteria had not been filtered out.[3] In this case the antibodies that are formed are called antitoxins.

The most recent method of preventing diphtheria in young children is based upon the stimulation of body reactions by such

[3] This is, whenever possible, a preferable method, as it means injecting less foreign material. Foreign material is always irritating, and even sterile substances, such as white of egg, not in themselves poisonous, may cause irritation, abscesses, fever, and even death when injected into animals in appropriate amounts and at certain intervals.

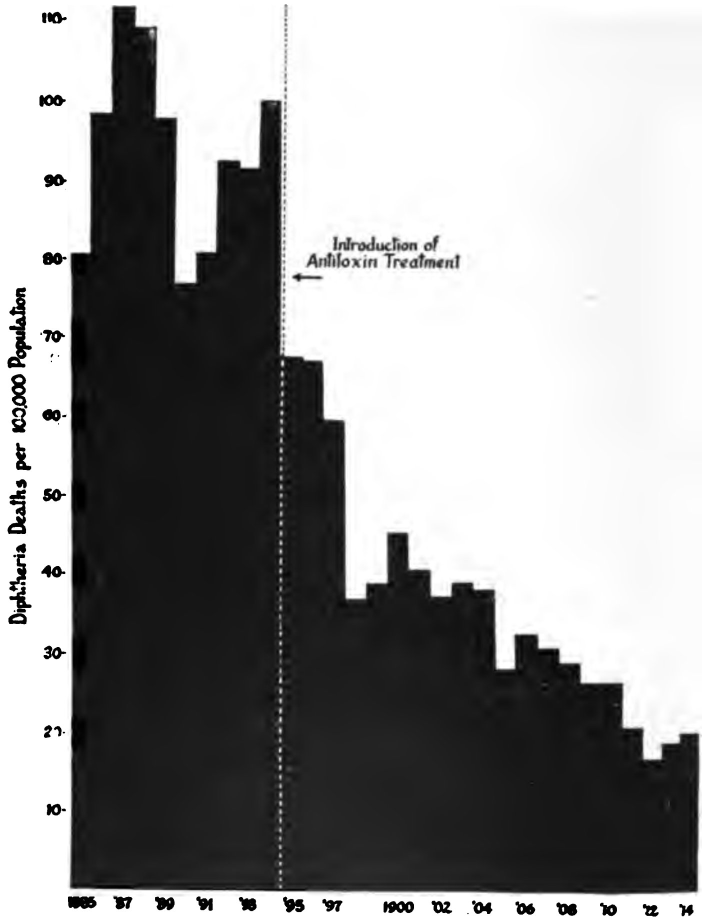
toxins. A modified diphtheria toxin is now inoculated to cause them to produce sufficient antitoxin to protect them against diphtheria during the susceptible period of childhood.

Even in diseases contracted naturally we do not, unfortunately, always react with sufficient promptness to prevent serious illness or death. It often happens, also, that many individuals do not respond sufficiently even when they are also stimulated by such substances as vaccines and toxins. Such cases may be aided by giving them the reacting substances formed by another person or animal and present in the blood of that person or animal (Fig. 54). In the recent infantile paralysis epidemic an attempt (on a small scale) was made to protect affected children by injecting blood from persons who had recovered from infantile paralysis.

It is difficult to secure sufficient amounts of such immune blood, and, when possible, animals are substituted. Horses are commonly used for securing such substances, as they are clean animals, free from most of the diseases that might affect man; and because it is possible to draw at one time sufficient blood—usually eight to twelve quarts—to make it worth while commercially. Antitoxins for diphtheria, tetanus, and for the gas gangrene infections are secured by injecting horses with the toxins of the respective organisms. This is not done, of course, to protect the horses, as they do not often have these diseases, but so that we may use their blood in treating human cases. Whole blood from such immune animals is rarely used, as practically all the antibodies are in the *serum*.[4] Instead, we eliminate the corpuscles, fibrin, etc.; after these have been extracted (by chemical treatment, filtering, etc.), the modified serum left still has high protecting qualities. Such modified serum is called by the name of the protective substance or antibody most prominent or most desired, *e.g.*, antitoxin. It is essentially the same substance whether produced in the human body or in the body of another animal. We "give antitoxin" from horses in treating human cases because the human being is not himself forming enough antitoxin to protect himself. Sometimes this modified serum, as described above, loses a great part of its desired substances, and the whole serum is used. Tetanus antitoxin and gas bacillus antitoxin

[4] Just as toxins may be less irritating than the bacteria themselves, so serum, too, may be less irritating than the whole plasma or liquid part of the blood. Our present refined antitoxins, for example, do not produce the rashes formerly produced when whole serum was used for diphtheria.

are practically serum; their antitoxic qualities are so marked, however, that they are, nevertheless, called antitoxins.



THIRTY YEARS OF DIPHTHERIA IN NEW YORK STATE

FIG. 54.—The effect of antitoxin on the diphtheria death rate is shown by this graph.

The following table describes briefly a few of the protective substances in common use. Most substances of this kind are injected into the tissues just beneath the skin (subcutaneously); they act more quickly if injected into a vein (intravenously, Fig. 55); in

diseases affecting the region of the nervous system they are preferably injected directly into the spinal canal (intraspinally, Fig. 56).

It is thought that the immune substances, agglutinins, antitoxins, etc., are produced mainly in tissues forming the blood-cells: the bone marrow, the spleen, and the lymph-nodes. In some cases

a *b*

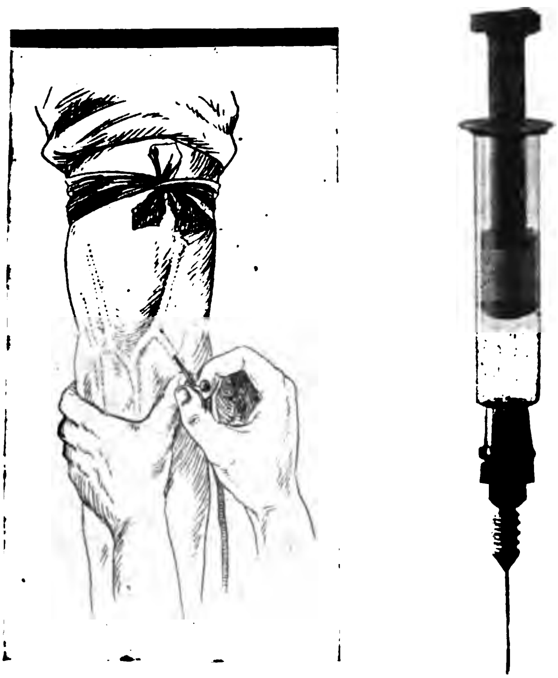


FIG. 55.—*a*. Intravenous injection of drugs, serum, etc., is done as shown here. In subcutaneous injection no effort is made to strike a blood-vessel. *b*. Syringe used in such injections.

antibodies seem to be formed also by tissues near the site of irritation or injury, *e.g.*, the lung area. The white corpuscles themselves may be a source of some of these immune bodies.

Immunity to disease as described in the preceding pages may be either active or passive. When quinine is given in daily or less frequent doses in malaria, the immunity gained is passive, and due to the quinine and not necessarily to any activity on the patient's

part. The same is true when serum or antitoxin is given. But when the bacteria or their products are given, they stimulate the individual to produce protecting substances. Such immunity is as truly active immunity as that gained when an individual contracts the disease "naturally."

Anaphylaxis.—Foreign proteins, not in themselves poisonous or unduly irritating, injected into the blood, may so sensitize the pa-

FIG. 56.—Intraspinal injection is more difficult; but much more efficient when it is necessary to bring protecting substances quickly into contact with infected nervous tissue, such as the brain and spinal cord.

tient to that particular protein that when a second dose is administered the individual is apparently poisoned or injured by it. This sometimes occurs when a second dose of antitoxin is given. The substance that should have protected the patient has apparently left him without any protection (*ana*, without, therefore ana-phylaxis). Sensitiveness to certain foods is sometimes explained in the same way. It is thought by some that a baby may be given too much of a new food the first time and form too much of a given enzyme or other reacting substance; he is then *sensitive* to that substance, and reacts very strongly when next it enters the body. Such food-sensitives are not uncommon for strawberries, milk, and

SUBSTANCES USED IN TREATING OR PREVENTING DISEASE

Protecting Substance	Disease	Remarks
Whole blood	Scarlet fever	Obtained from convalescents; their serum only also used
	Anemia Loss of blood, *e.g.*, by wounds	Not to add antibodies, but to supply oxygen-holding power, etc.
Whole serum	Pneumonia	Not helpful in all types of pneumonia
	Meningitis	Preferably injected intraspinally
	Tetanus	Preferably injected intraspinally in advanced cases
	Gas gangrene	Now obtained from the same horses that produce tetanus antiserum. (The horses are injected with *two* toxins: tetanus and gas bacillus). This double serum is now being tried at the front with *promising results*
Purified serum or antitoxin	Diphtheria	
Living organisms (or vaccines)	Smallpox	Originally obtained from cowpox; now smallpox organisms which have been grown in healthy calf are used
	Rabies	Now obtained from spinal cord of rabid rabbits
Killed organisms (also called vaccines)	Typhoid	Immunity lasts 2–5 years
	Paratyphoid yDsentery	Intestinal disorders; typhoid is used with these to make the "triple vaccine" used on all our army in this present war
	Cholera	
	Tuberculosis	Killed tuberculosis bacteria are called tuberculin; not curative; helpful in other ways (healing, etc.)?
	Boils and skin eruptions	Staphylococcus and the acne bacillus are the common organisms used
	Plague	Useful in epidemics only, as immunity lasts but a short time
	Whooping cough	Either the pertussis (whooping cough ?) or the influenza organism gives fairly good results

Protecting Substance	Disease	Remarks
Killed organisms (also called vaccines)	Common colds.......	Various pure and mixed vaccines are used, benefits most uncertain
Filtrates of killed bacteria or *toxins*	Diphtheria...........	Recently used for exciting antitoxin in children; a little antitoxin is mixed with the toxin to lessen the shock and irritation
Replacing bacteria by other kinds	Typhoid........... Intestinal disturbances, including dysentery and chronic indigestion	Sour milk containing acid-forming bacteria used as foods. See page 89
	Diphtheria..........	*Staphylococcus* has proven fairly successful in overgrowing diphtheria and so curing such carriers

eggs. Sometimes the sensitiveness varies with the treatment the food has undergone (*e.g.*, cooking). People who are subject to hay fever, rose cold, etc., are thought to have been previously sensitized by pollen from such plants or similar substances. The repeated use of tuberculosis proteins in tuberculin is by Vaughn and others classed as dangerous for much the same reasons. Some of our best sanatoriums still continue this treatment, however.

PROBLEMS

1. When measles were first introduced into the Faroe Islands, over 6000 of the 7782 inhabitants contracted the disease; show why that proportion could not be reached in any of our communities today for measles. What part does "a wall of the immune" play in controlling communicable diseases?

2. Consult one of the bacteriologies given in the reference list and make a list of the diseases in which prevention by vaccination, etc., is possible. Check those which have come under your own observation. What is the relative prevalence of such communicable diseases?

3. Write a popular article in favor of antitoxin, making it so clear and convincing that it would appeal to an eighth-grade child.

4. The statement has been made that the cure for quarantine is sanitation. What sanitary measures would make an epidemic of typhus fever impossible in your city? One of cholera? Of smallpox? Of yellow fever? Of plague?

5. In the diagram (Fig. 52) what period represents the so-called crisis of a disease, the point that means recovery or death? Why is the recovery often very rapid after this crisis is passed?

See Reference List at end of Appendix.

CHAPTER XII

TESTS FOR DISEASE[1]

THE presence of disease organisms in our bodies may be demonstrated in two main ways: (1) by examination of secretions and diseased tissue for the suspected bacteria; and (2) by demonstrating that the body has formed certain of the antibodies we have already discussed (*e.g.,* agglutinins). The presence of such antibodies is considered proof that the individual has had or now has the related disease. These tests for disease are most important aids, not only to the individual but to the whole community. They often make possible an earlier diagnosis of a given disease and enable the patient to obtain more helpful treatment; they also protect the community by leading to an earlier establishment of isolation or quarantine when that is necessary.

Carriers.—In certain diseases, *e.g.,* typhoid and diphtheria, the organisms may persist in the body even after the individual has apparently recovered, the individual having acquired a tolerance to the organisms thus retained. These same kinds of tests enable us to determine whether or not the bacteria are present in these apparently well people; and the community can to some degree protect itself against these carriers by demanding their isolation, providing curative treatment, or refusing to allow them to follow occupations certain to spread such organisms (*e.g.,* food handling by typhoid carriers).

Microscopic Tests.—Direct examination of secretions, etc., is the method often employed in diphtheria, tuberculosis, gonorrhœa, typhoid and cholera.[2] In diphtheria a little material from the in-

[1] Chapter XI should be read before this chapter. These tests are mainly biological tests; other tests, such as X-ray, though important, are not included here.

[2] These are not the only methods used for these diseases. They are, however, in general use, and typical of methods used in other diseases too complicated to describe in this type of book; these descriptions are designed to give but a general idea of these tests. Training is, of course, necessary to make and interpret such tests; this includes a special technic desirable both from the standpoint of the individual and the community, protecting the patient by the use of sterile instruments for the collection of material, and the community by properly handling and disposing of such materials.

fected throat is rubbed upon a glass slide. When this is stained (G) diphtheria organisms may be identified in the microscope by their characteristic appearance (rods slightly swollen at one end and presenting with appropriate stains an unequally stained or spotted appearance, Fig. 57). Streptococcus infections are also easily identified microscopically (Fig. 58) (septic sore throat, mastoid abscesses, etc.). Tuberculosis is diagnosed in much the same way. Sputum (G) from a tuberculosis suspect is placed upon a glass slide and stained; once stained, tuberculosis bacteria retain their stain with great tenacity, even when bleached for a short time in alcohol or acid. If, after bleaching, deeply-stained, slightly

FIG. 57.

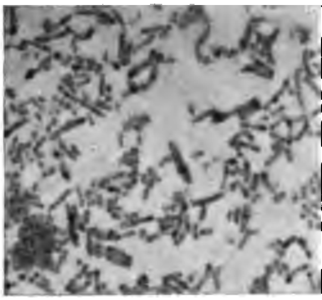


FIG. 58.

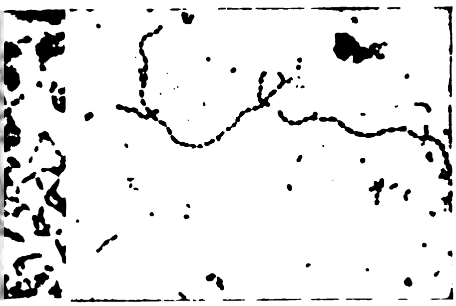


FIG. 57.—Diphtheria organisms magnified more than 1000 times, showing distinctly their unequal staining character.

FIG. 58.—*Streptococcus*, a long-chained form, important as causal organism in many different disease conditions, such as mastoid abscesses, scarlet fever sore throats, and blood poisoning.

granular rods are found, the case is diagnosed as tuberculosis (Fig. 94).

A common way of diagnosing gonorrhœa is by examining microscopically mucus from the inflamed area (eye, genital region). If gonorrhœal in character, the slide when stained in a special way will show peculiar pairs of rounded organisms and numerous white corpuscles, many of which are sure to contain numbers of these same rounded organisms.

In meningitis material withdrawn from the spinal canal (Fig. 59) is examined both bacteriologically and chemically. This spinal fluid is examined bacteriologically by making a direct examination

to determine the causal organisms. Parallel chemical tests relating to the sugar and albumin content of this fluid are often made.

Diagnosis by Isolating Organisms.—Meningitis, typhoid, and cholera are diagnosed in a different way. The nasal secretions in meningitis carriers and the fæces in typhoid and cholera patients as well as carriers contain the disease-producing organisms. A little

FIG. 59.—Method of collecting spinal fluid for bacteriological and chemical examination.

of the nasal excretion or a little of the fæces is spread out on a plate of (solid) material favorable to the growth of the suspected organisms. In the resulting growth on the plate it is quite easy for an experienced person to identify the colonies of meningitis, typhoid, etc.

Agglutination of Isolated Organisms.—These organisms can be positively identified, however. In meningitis, for example, a little of the selected colony is mixed with serum obtained from a person known to have meningitis. If the growth is meningitis, the

organisms are agglutinated or clumped by the serum as described in the preceding chapter (p. 196).

Diagnosis by Antibodies in Blood.—The second way of proving that a person has a given disease is by demonstrating that he has formed in his body certain of the antibodies we have already discussed (see p. 196). In diagnosing typhoid a little blood is taken, and to this blood (or preferably the serum) are added some known typhoid organisms. If the organisms are agglutinated by the patient's serum, we know he has the same antibody (agglutinin) that

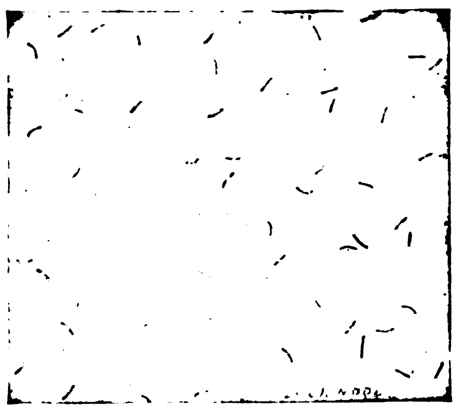


FIG. 60.—A drop of broth containing free-swimming typhoid organisms, magnified about 1000 times.

typhoid calls out, and conclude he has typhoid fever (Widal test, Figs. 60 and 61).

Tubercular people may be shown to have tuberculosis by their reaction when killed tuberculosis organisms (tuberculin) are injected into them. Swelling and reddening at the place of injection and fever are the main reactions looked for; if these occur within a specified time, it indicates that the individual has tuberculosis. This test—the tuberculin test—is very well known; but many people feel it is not a wholly reliable test for active tuberculosis, partly because people who have had tuberculosis at some time and recovered may retain the reacting substances for a long time, and therefore react positively to the test. It is much more reliable for cattle than for man.

One of the newer tests is the Schick test to determine whether a person is liable to diphtheria; in this a small amount of diphtheria toxin is injected into the arm. If the individual has, naturally or because of an earlier attack of the disease, the necessary neutralizing substance in his blood, the toxin will be absorbed with a minimum amount of swelling, redness, etc.; if the individual is susceptible to diphtheria, the toxin thus injected will not be neutralized and will therefore be irritating, and cause a certain type of persistent reddened swelling; such people should be protected from diphtheria

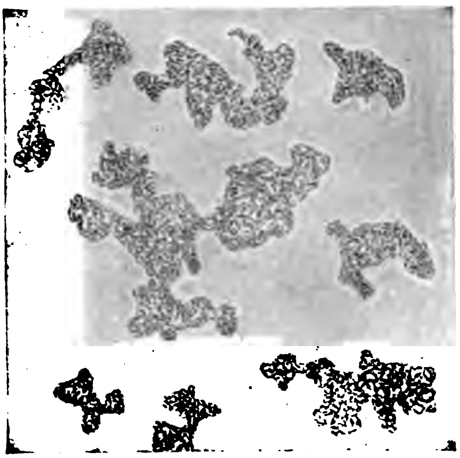


Fig. 61.—Typhoid organisms, clumped or agglutinated by the addition of the serum of a person who has typhoid.

(especially if an epidemic is threatened) by a dose of antitoxin, or by the newer modified toxin treatment (p. 207). This test is very valuable—showing which of the exposed individuals need protection, and making it unnecessary to use antitoxin treatment on those who do not need it—a saving of thousands of dollars yearly in children's institutions, including schools.

Difficulties in Diagnosis.—Occasionally such tests fail. This is not because they indicate that the disease is present when it is not, but because they fail to indicate the presence of the disease organisms, giving negative results instead of positive ones. Most of these are easily explainable. The small sample used from the

nose, throat, or fæces may not chance to contain any of the organisms. In the other tests, depending upon the formation of agglutinins, etc., a negative result may be secured at the beginning of the attack, because the patient has not yet begun to react to the bacteria. In serious or fatal illnesses where the patient is not successfully combating the disease, it is partly because he is probably not producing sufficient antisubstances to protect himself or to show up in a test. In such cases the clinical or bedside symptoms are usually quite definite and positive, however.

Common Tests Depending on the Presence of Antibodies in the Patient's Blood

Antibodies present	Diseases	Remarks
Antitoxins	Diphtheria	Used to prove immunity to diphtheria, not presence of disease
Agglutinins (and precipitins)	Typhoid Paratyphoid Dysentery	
	Pneumonia	Used to determine type of pneumonia and to indicate whether prepared serums can be used in treatment
	Transfusion of blood	Incompatibility indicated by the rate at which foreign cells are precipitated by patient's serum
Opsonins	Tuberculosis	Used mainly to indicate the *condition* of the patient; not very satisfactory, apparently
Lysins	Syphilis Gonorrhœa Whooping cough	These are complicated tests in which several other substances may be used. In syphilis, for example, if the patient has syphilis, his serum affects the substances used in such a way that the red blood cells also added to the mixture are not dissolved (Wasserman test)
	Transfusion of blood	Danger indicated if the patient's serum rapidly dissolves the red cells in the blood to be injected

PROBLEMS

1. The tests described in this chapter have been described in the simplest form possible; they are really much more detailed and complicated. What arguments can you advance for having a special city or county laboratory for making such tests? (Include cost of equipment, necessary training in chemistry and bacteriology, and the time demanded.)

2. Which of these tests do the physicians in your town make in their daily practice? Are more needed for the full protection of the community?

3. Visit the nearest health department laboratory and find what microscopic and biological tests are made there. What tests are made for disease in animals other than man?

See Reference List at end of Appendix.

CHAPTER XIII

THE HOME

Most of us are individually responsible for the care and hygienic conditions of a small number of rooms or, at least, a single room. For each of us the problems are much the same, as even the occupant of a single room must share with others the bath and toilet facilities, and also the commodities stored and prepared in the cellar, kitchen, and dining room of the same building, or in one differing little in sanitary conditions. Whether one builds his own house or leases an apartment or only a single room, the hygienic interests and responsibilities [1] are still the same, for in each case there is an element of choice.

The main considerations (*e.g.*, water, ventilation) are all treated separately in other parts of this book. The purpose of this chapter is to make the problems more concrete for the sake of the individual housekeeper. Even with the services of a capable architect conversant with all the sanitary details, one may find faulty construction which will always affect the occupants, such as too great consideration for the outside appearance of the house which may so space the windows that a room has but a single window and that on the sunless side of the house. Of what avail are city ordinances requiring windows in bathrooms, if soiled or leaking toilets are tolerated? What benefit does a taxpayer derive from an expensive system of garbage removal, if accumulations of table refuse draw the disease-carrying flies and mice to his own kitchen?

Housing Regulations.—Housing laws are intended to provide proper standards for the erection, maintenance, and alteration of dwellings, that is, "buildings occupied in whole or part as the home residence or sleeping place of one or more human beings either permanently or transiently." It is remarkable that this type of social legislation which was drawn first to safeguard the tenement

[1] Those responsible for building or planning houses, or even one-room schools, small churches, etc., should consult more advanced books than this, including not only those mentioned in this book, but the more technical authorities to which they may in turn refer.

dwellings in congested quarters of large cities is now widening its scope to propose, at least, certain standards for every dwelling within a State, whether in the city or rural district, whether a one-family house occupied solely by the owner's family, or a multiple dwelling occupied by many families. The principal provisions of such laws as given by Veiller in his "Model Housing Law" concern guarantees of adequate light and ventilation, proper sanitary provisions, fire protection, and suitable conditions of occupancy. Adequate light and ventilation is made certain by (*a*) limiting the proportion of a given city lot which can be covered by the dwelling (*e.g.,* 70 per cent. or less of the area of an ordinary interior lot and 85 per cent. of an ordinary corner lot); (*b*) requiring that the rear of every lot be left as an unoccupied area of at least 15 per cent. on a corner lot and 25 per cent. on an interior lot; (*c*) that side yards, if used, should have a minimum width and be open to the sky; (*d*) that every room is to have at least one window opening on the street, or yard or court, which must be of specified size (small courts or air shafts are forbidden by rigorous requirements); and the area of these outside windows must be at least one-seventh the floor area of the room (this provision makes illegal inside rooms, dark rooms, and alcove rooms); (*e*) every room except the toilet must have at least 90 square feet floor area, and in multiple dwellings there must be in each apartment one room of 150 square feet, and no room may be less than 9 feet high.

The sanitary provisions require running water and indoor flush toilets in every dwelling and family unit of every dwelling; the bathroom as such is not required by the housing law. Detailed safeguards regarding fire prevention are also included; these cover exits, fire escapes, and the methods and materials of house construction.

The legal standards regarding maintenance include the care and cleaning of halls, cellars, and courts in multiple dwellings; the disposal of ashes and garbage; prohibition against keeping animals on the premises, and the storage of combustible material; also standards as to overcrowding, and relating to moral conditions.

Location.—No one would from choice select marshy ground as a site for a house. Even the small surface bodies of water in places but slightly marshy are dangerous as well as unsightly, as they afford breeding places for malarial mosquitoes. It is, how-

ever, no unusual thing to find houses on the edges of towns, highways, and railway embankments more or less surrounded by visible water a considerable part of the year. Made ground is usually filled-in marsh land and is often water-soaked; it may also yield objectionable odors due to the refuse used for filling in.

Water-soaked soil is not favorable for gardens either for flowers or vegetables. In such soils the water replaces the air ordinarily present in soil, and the roots suffer for lack of oxygen. (Everyone can doubtless recall seeing wheat or other crops which had sickly yellow-green color during a long-continued wet spell in spring or early summer.)

Damp soil (where the level of the ground water is very near the surface) can take care of very little extra water (*e.g.*, rains, house water). Such soil is liable to become temporarily, at least, wet and sour or foul-smelling. During this present year one of King George's palaces in London was refused as a hospital, because it was found impossible to avoid unpleasant gases emanating from the soil below, which, during the centuries before modern plumbing was installed, had been soaked by house and stable waste. Queen Victoria, it is said, claimed the conditions affected her health, and would not stay over night in the palace and never more than a few hours at a time.

Cellars.—Cellars in wet ground usually contain water, unless considerable money is spent in waterproofing the outer or soil sides of the walls and floor. Loosely filled layers of stone may also be placed outside and close to the foundation, with a drain near the bottom of the foundation wall to carry off the water that collects there (Figs. 62 to 65).

As the air in the house becomes heated and rises through the house, it is replaced by outside air. Part of this comes through the windows and doors on the various floors; sometimes a special fresh air intake is provided; much of it comes from the cellar and the adjacent soil. Too great care in closing all the cracks of the doors and windows may increase the amount of cellar and soil air replacing the air which is constantly passing out of the chimney and upper part of the house. In fact, the greatest precautions (asphalt insulation, etc.) are necessary to prevent considerable replacement by soil air. Since these involve considerable expense and delay the

beginning of building operations, they are rarely taken, unless there are indications that water will actually flood the cellar.

Though the ground water level (G) meets the requirements (eight to ten feet below the surface), the cellar *floor* may be near or even below that level and the cellar may be surprisingly damp, unless the floor has an asphalt layer below the cement (Fig. 64) or is underdrained by loose stonework below the cement floor.

The cellar, especially in country districts, is often but a dark, damp hole, so damp that visible moisture is usually present on its

Fig. 62.—A rough-backed wall, not advisable for damp soils, as it has projecting surfaces in which water may collect. What will be the effect on such walls if the collected water freezes?

walls, and so poorly windowed and ventilated that it is musty-smelling; it is quite common for cellars to be so dark that one has to find things "by the feel" instead of sight, and if work is done in the cellars (skimming milk, cutting meat), the materials must be carried close to the window. The dirt floors, the moldy boards for walking, and the musty shelves and benches are doubtless familiar to many readers. Many a person has grown to maturity without ever seeing a cellar that had a cement floor or two windows placed to insure cross ventilation.

It takes an undue amount of a housekeeper's time to be constantly dragging boards, benches, and shelves out into the sun to keep things fresh and clean. The cellar ought to be as easy to care for as any other room in the house. Usually it is so unattractive a

task that the annual spring cleaning and whitewashing have "a hated deed done" as their only incentive.

Cellars that grow musty easily should be cleaned, aired, and whitewashed often—more than once a year. Whitewashing need not be made a distasteful or difficult task, now that lime can be secured in tin cans. An old tub or barrel can be kept for mixing purposes, and with a tin spray pump costing but $.60 to $.90, the lime can be squirted over the walls, especially in the darker corners. Lime is probably the only legitimate deodorizer, as it also covers the old surface with a fairly efficient disinfectant.

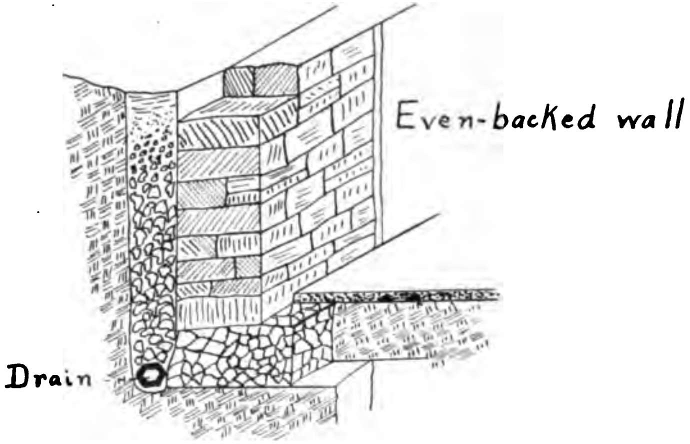


Fig. 63.—This smooth-backed wall does not have the two disadvantages implied in Fig. 62; the drain at the bottom is an added protection against dampness.

Exposure and Light.—One is often at a loss to account for the locations of old houses. Views and a convenient distance from the road were usually sacrificed to two things: nearness to the spring or well, and shelter from the winter blasts. The position of the barns and other out-houses was a matter of less concern; this accounts for their common location higher on the valley sides than the springs or well. That this aroused little concern is not surprising, for the first well-borne epidemic due to fæcal contamination was not worked out until 1854. To-day the relative location of the cesspool and well are equally important.

"Facing the south" is such a familiar term that it needs no

explanation. Too often the coveted exposure goes to the unused parlors and the living and working rooms are sacrificed. If the house is placed so that one side faces either the southeast or the southwest, then every side of the house has direct sunlight part of the day. Note (Fig. 66) the difference this would make to the kitchen, which so often is a rear addition to the main part of the house.

The stimulating effect of sunlight is realized by but a few; its disinfecting value is still less appreciated. It is not unusual to find the shades down for days at a time—not to shut out the glare, but

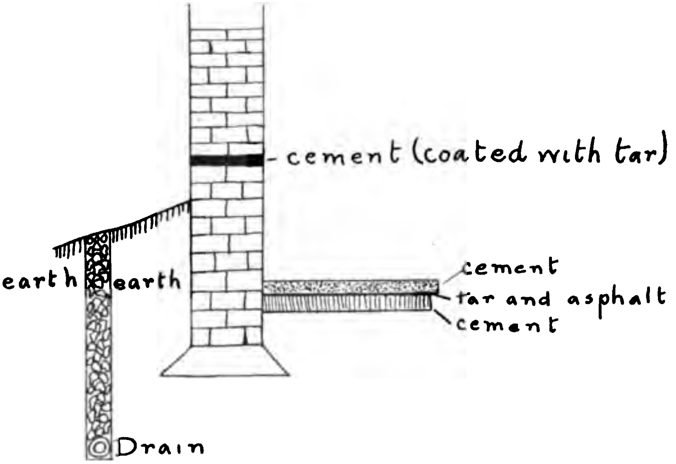


FIG. 64.—It is sometimes desirable to collect the drainage water some distance from the house, as in this diagram. Note the cement-tar layer to prevent the upward transfer of moisture through the walls. The cellar floor is similarly treated.

to keep the furniture and carpets from fading. Even to-day there are housekeepers within an hour's distance of Philadelphia or New York affected with such an acute form of "carpetitis" that newspapers are spread upon the carpet when the shades are raised. The cheapest and quickest of our natural disinfectants, sunlight, is lost by concern for carpet roses.

Artificial Lighting.—The lighting problems are chiefly concerned in remedying two extremes: too little light and too much light. It is no exaggeration to find halls and bathrooms so dimly lighted that one can barely see the light itself. Some standard

(such as reading newspaper print at a given distance) should be demanded of all people who rent out one or more rooms or apartments. Gas lights should not be turned so low that ordinary drafts would blow them out. Kerosene lamps, if turned too low, give out a disagreeable smell due to the fact that the small flame does not cause complete combustion. The "mellow" light claimed as an advantage of the kerosene light can be secured very easily from gas or electricity by proper shades. (See paragraph following.) The

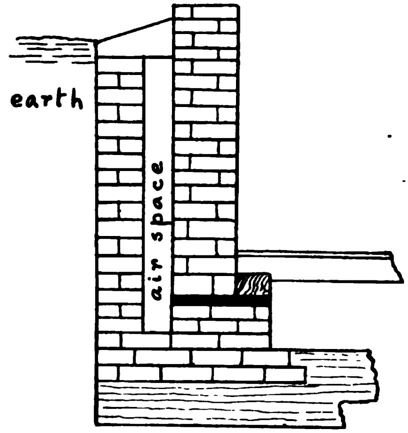


FIG. 65.—Air spaces are also helpful in counteracting the effects of damp soil against the wall.

electric light has two great advantages besides convenience; (1) it is easily and safely led off or adjusted to more convenient positions, and (2) it does not complicate the heating and ventilation problems as gas and oil do. Both gas and kerosene add heat to the surrounding air; both reduce the amount of oxygen; kerosene may give out objectionable odors and smoke, and there is a risk of CO (G) poisoning in illuminating gas (see Chapter VI). Artificial light has a slight inhibiting effect upon bacteria, another argument for its generous use.

Formerly brilliancy of illumination seemed our sole aim. No light was ever put "under a bushel," but even electric lights were placed in the most exposed parts of the room, with a reflector back of each. Fortunately indirect lighting is now fashionable and our

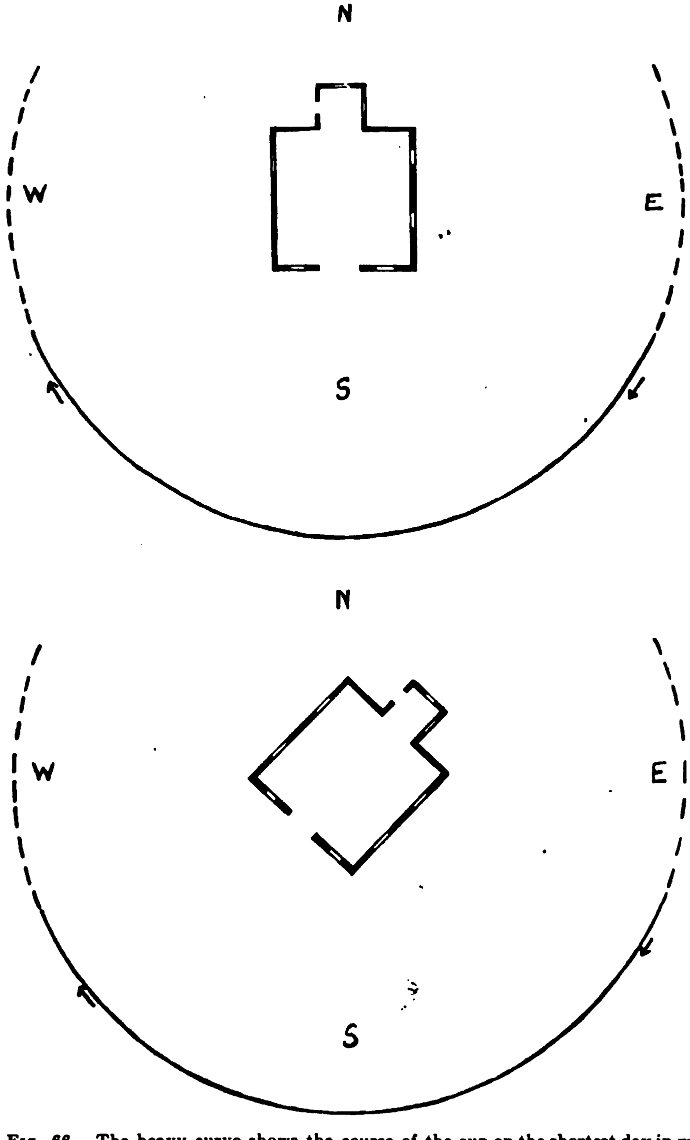


Fig. 66.—The heavy curve shows the course of the sun on the shortest day in winter, the broken line on the longest day in summer. Notice how little light really enters the east and west windows in winter in the face-to-the-south exposure. In the corner-to-the-south position notice the better illumination of all rooms, including the kitchen extension.

public buildings, halls, etc., quite generally have shades between the eye and the source of light. Translucent bowl-like coverings hang just below the ceiling light and curved semi-opaque shades are placed in front of the wall lights. These usually serve two purposes. They give out through these coverings a soft mellowed light, which is widely diffused through the room; much of the light is thrown up against the ceiling or back against the wall and from there reflected back into the room.

Indirect lighting means a more diffused light and a less glaring light, and consequently less eye strain. In private homes it is used mostly in halls, reception rooms, or for the general lighting of a room. Rooms used for reading, writing, or other close work should have attachments placing the light near the hand or working level. A translucent globe (open at the bottom) gives through the globe a diffused light throughout the room, and through the opening throws most of the light downward on the work at hand. If this is too strong, thin gauze or silk can be drawn across the opening at the bottom of the globe, giving a softer light. Some advocate a green glass globe, half-spherical in shape, which is turned toward the eye, the open side toward the wall, and the light is reflected from the wall to the work. Most people express a feeling of impatience with indirect light of this last type for close work, and though it is quite probable that habit may make us demand irritating over-brilliancy, it seems as if it is often an individual matter, and each should control his individual arrangement for close work. For general illumination, there can be no doubt that indirect lighting should be adopted.

Heating and Ventilation.—The various methods of heating may be divided into two groups: (1) those involving a special heating plant in the cellar or basement and supplying heat by pipes or flues to the various rooms of the house; and (2) those utilizing the various fuel substances (*e.g.*, coal, gas) in the room which is to be heated.

Hot-air Furnaces.—Coal, wood, and, less often, oil are burned in specially constructed stoves or furnaces. The oldest and simplest of these special furnaces is the type in which air from a more or less confined area over the burning fuel is collected and carried in large (tin) pipes to various rooms on higher levels, entering the rooms through grated inlets set into the floor or the walls. Such air.

even with careful control of the dampers, often carries with it "coal gas," including disagreeable odors and the poisonous CO gas. There is often a burned odor, due chiefly to dust particles which find their way from the rooms down into the hot-air flues. Usually such air is too dry, for even though comparatively fresh outdoor air makes up the bulk of such heated air, it becomes relatively drier as it is heated (see p. 124). Often it is so dry that water evaporates too rapidly from the body, chilling it; and to prevent this chilled feeling an over-high temperature is demanded. A "water box" is often provided, but is usually too small, and the incoming air passes over it too rapidly to take up the necessary amount of water. About fifteen gallons are needed daily if sufficient moisture is supplied for a medium-sized house containing 17,000 cubic feet. Usually, too, it is cold outer air that is in contact with the water, not the warmed air, with its greater holding power for water, and so little real benefit is derived from the water box.

Recent Warmed-air Systems.—Recently an improved, "warmed-air" system has been introduced. The air that passes through the furnace in the system just described is not used, and all the products of combustion pass with it out the chimney. Fresh outdoor air is taken in through special inlets and passed in *closed* pipes through the upper part of the furnace and, as it becomes heated, on to the rooms. This avoids the objectionable gases, but may leave the burned odors before mentioned. This system usually provides water contact with the *heated* air to increase its humidity.

The lack of moisture in room air can be partly supplied by dishes of water exposed in the room or by boiling water for a short time. We must remember that steam may condense on the cold windows before the general room air has reached a favorable humidity. Most people object to having moisture collect on the windows; boiling is an added task, and dishes of water are apt to collect dust, becoming unattractive, though not necessarily harmful. It is, therefore, much wiser to see that the incoming air has in it a considerable amount of water.

Hot Water and Steam Systems.—In the other special heating plants in this group the heat of the furnace is used to heat water. This heated water either circulates through the house as warm water, or it is heated enough to convert it to steam, and the steam passes to the various rooms. As the warm water gives out its heat,

it becomes chilled and relatively heavier. It therefore passes to the lower pipes and finally down to the furnace to be re-heated, making a constant and continuous circulation. Steam, in the steam-heating system, as it gives its heat out to the rooms, is condensed to water, and this water similarly makes its way back to the furnace.

Hot-water systems give out heat constantly, even though but a slow fire is maintained; they are better adapted to the yearly range in temperature, and they are more economical of time and fuel. Steam has the disadvantage of not providing any heat except when the water in the boiler is kept at or above the boiling point. It, of course, responds more quickly in emergencies (cold snap, heating after an unoccupied period). Both these systems are open to the same objection felt in the hot-air systems—excessive dryness; this condition can be improved only by exposing added water (as described) in the rooms themselves. Steam heat is often described as more drying than hot-water heat. There is really no difference, except that steam-heated rooms are more often highly overheated and, therefore, relatively drier. Hot-water systems do *not* give out moisture.

Room Heaters.—In the other type, utilizing the fuels in the room where the heat is desired, we have the methods common in small houses, one-room schools, etc. Not only do the special cellar heaters imply expensive construction, but the consumer loses much of the heat, perhaps half the fuel value of his coal. In most homes, where labor is rarely valued highly, the more economical plan of utilizing the fuel in the room is followed. In these methods the problems are mainly (1) the distribution of the heat evenly throughout the room, and (2) the avoidance of objectionable products of combustion (*e.g.*, CO, odors). The choice of fuels is mainly decided by the care or time demanded, and the cost. Electricity, unless water power can be utilized for its manufacture, is an expensive form of fuel, as it represents but part of the fuel value of coal. It, however, presents no ventilation or labor difficulties. Gas, too, represents but about half of the fuel value of coal. Gas and kerosene mean but little work, but they make heavy demands upon the oxygen of the room, and the products, including those of incomplete combustion (smoke in kerosene, and the poisonous CO gas (G), especially in "water-gas" (G)) all pass out into the room. Gas logs in apartment houses are often set in without any connection

with a chimney or ventilating flue. Choice, especially in the country, is often limited to the cheaper wood and coal, coal being the favorite, because its better keeping power does not demand constant replenishment. Time and convenience, however, make gas, electricity, and kerosene valuable sources of heat. As emergency aids, they are at times invaluable.

In general, all fuels burned in the room are open to the same objections: (1) they use up oxygen; (2) they give out slight odors accompanying combustion; (3) they may give out harmful products (smoke in kerosene stoves, CO gas from coal and illuminating gas, especially if an incandescent surface is present: the red-hot sides of a coal stove or the charcoal-covered burner of a gas stove); and (4) they are almost always constructed and operated without any provision for replacing the room oxygen. Though the oxygen lack rarely leads *directly* to human discomfort, it may decrease the rate of combustion. This is more marked in such fuels as gas, giving for a given unit of gas less heat, and, unfortunately, allowing much gas to escape into the room unconsumed. If the gas is "water gas," which contains a large amount of CO, this poisonous gas may accumulate sufficiently to cause stupor, paralysis, and death.

The distribution of heat in the room is a difficult problem. Too often the floor or distant corners remain cold, while the stove region is uncomfortably hot. This is met partly by placing a screen or jacket around the stove; this shields those near by and still allows a general distribution of the heated air through the room.

The jacketed stove is described under schools (Chapter XV, p. 260, Fig. 80).

Fireplaces.—Though fireplaces are wasteful as heat producers, they combine ventilating benefits with some heat production; their use is to be encouraged, especially where the ventilation is insufficient. Where a fire is burning the main air current is up the chimney, especially if adequate air enters the room in other ways. In a fireless fireplace, colder, heavier air may be *entering* the room through the fireplace. (A candle will indicate the relative rate and direction.) Such incoming air may be sooty in odor, but it is, of course, unused air.

Franklin Stoves.—The Franklin stoves combine the possible advantage of the fireplace with the greater heat yield of most stoves; having dampers to control the escape of heated air up the

chimney, and having also greater radiation surface in the room itself. In all these methods, the humidity tends to fall below the requirements necessary, and this need should be met as recommended in the other system, or more rapid evaporation and greater humidity may be secured by keeping pans of water on the coal stove, oil heater, under or on the gas radiator.

Ventilation.—The heat problems are summed up in (1) adequate heat for physical comfort with a generous margin for fresh air replenishment; and (2) elimination or avoidance of objectionable products (chiefly CO).

We ventilate freely in summer time, because the gains are realized immediately: decreased temperature, increased body loss of heat, etc.; but in cold weather the desire or necessity for economy dictates very different action.

We must reconcile ourselves to the loss of heat, if we are to keep the air up to the standards of comfort and cleanliness. We cannot get rid of odors, for example, without losing the heat in that same odor-bearing air. We must remember that we are paying for good heated air, and not heat only. Clean unused air is just as important as clean floors, shining windows, and dustless furniture.

Rules for Ventilation.—It is impossible to give any rules for ventilation that will suit even a one-occupant room. The natural ventilation through cracks, porous walls, and casually opened doors varies greatly; planned ventilation varies even more, depending upon the size, shape, and relative position of the openings (Figs. 33 to 35), and upon the difference between outdoor and indoor temperature. The main current in a fireplace, as already shown, is not always up and outdoors. Adequate ventilation based on these differences, the size of the room, and the number of occupants, can be worked out mathematically, but that method cannot be briefly explained in usable form. Fortunately there are two simple aids which will usually accomplish this same result: (1) a thermometer, to make sure the room does not become overheated, and (2) the human nose. No room—night or day—should smell "stuffy" to one entering from outdoors. In the daytime frequent short trips outdoors will benefit the occupant and also enable her to judge of the quality of the air.

The needs of most home-makers will probably be met by the following rule: Ventilate in winter much as you do in summer. In

summer no diagrams are necessary to convince people that two openings are better than one, even if in the same window; that they are more effective if on different or opposite walls of the room; and that a cross draft changes the room air more quickly.

Night Ventilation.—Night ventilation, if it means cold morning dressing rooms, is often most inadequate. Where space allows, one or more sleeping porches or open-window rooms may be set aside for this purpose, the individuals using the warm rooms for dressing rooms. Most families do not have an extra room for such purposes; in fact, every room is usually used night and day. Sometimes, however, inadequate night ventilation has no excuse. Ogden cites a family of five, living in a ten-room house, who slept in one medium-sized room containing but one small window, which was nailed shut. Recently two guests visiting a country relative near New York City found themselves consigned to a bedroom in which all the windows were nailed shut.

If the night temperature falls very low, outdoor sleeping will be injurious, unless adequate bedding can be provided. The same benefit can be derived from sleeping indoors, if the bed is placed in such a position that the head of the sleeper is out of doors; or the bed may be left wholly inside the room, and some form of sleeping hood provided which will not necessitate loss of room heat. That is much more easily done than most people imagine (Fig. 36). A string or pulley attachment for closing windows a little before the dressing hour will reconcile many people to a colder bedroom than they will otherwise tolerate. (See also Ventilation, p. 139.)

Kitchen.—Next to the cellar, the most important room in the house, from the point of view of health, is the kitchen. No one will contradict the statement that the places where food is stored and prepared should be the most sanitary places in the whole house. If dinner guests at many an elegant home could have one preliminary glance at the kitchen or watch the preparation of the food, there would be a wild rush for the door.

This situation is partly due to the poor quarters provided for kitchen and for the servants. Have you never wondered why it is necessary to have the kitchens little stuck-on additions to the houses? Why are they not dignified into integral parts of the house? Instead, we find the rooms where mistress or maid spends most of the daylight hours cut off from the interests of the street,

or the attractive part of the grounds; and the view is often limited to a high board fence or unattractive chicken pens. It does fix (more than we realize) the type of individual willing to work as kitchen helpers.

Food Problems.—Too often the kitchen employee is mentally and instinctively lacking in appreciation of the niceties necessary in the handling of foods, and often herself a carrier of disease (typhoid, dysentery, tooth and gum diseases); these make her a double menace to the family.

Dirty sinks, food trays and floors attract insects, Croton bugs and flies from neighboring apartments or houses, including toilets and privies. Kitchens should be screened and kept free from water bugs, cockroaches, etc. (see Appendix). Mice may be dangerous, and the conveyance of typhoid by rats from an infected sewer has been demonstrated. No one willingly eats food after such unclean animals have travelled over it, and it should be made impossible.

The preparation of food involves the greatest consideration for others. Licking the fingers, handling the handkerchief, using the dish towel as a hand towel or napkin, dipping the tasting spoon back into the food, are a few of the habits all too common, whether servants or members of the family handle the food. How disgusting it is, they usually do not realize, though they would be grossly insulted if one made such statement as, "This delicious meal you are serving contains 30 deposits of saliva or nasal excretions." Such offenders are often otherwise very dainty in food service. More than one housekeeper "cannot understand why X never will stay to dinner."

Every effort should be made to remove the results of careless handling by others. Careless grocery and milk delivery men often touch food with their hands which cannot help but be soiled with objectionable material (*e.g.,* by reins which too often fall down into the dirty street). Most food materials are sold in packages, or protected by paper covers, or are washed or cooked before using; but unwrapped bread is too often carried in soiled hands or against soiled clothing, or piled on the floor of wagons on which the driver often steps with street-soiled shoes. Milk bottles are almost always carried by the rim, over which the milk must be poured. Milk bottles should be washed thoroughly before the top is removed, paying special attention to the rim itself. If the rim is wiped dry, it

should be done with a bit of clean paper towel or with an unused cloth—not with the dish cloth.

Vegetables that are eaten raw should be thoroughly rubbed or scraped, and rinsed in several waters. Lettuce and celery are very difficult to clean (Fig. 67). Typhoid cases have been traced to lettuce, and the habit of adding human excreta to truck gardens is fraught with danger. Typhoid has been experimentally recovered from lettuce months after such addition to garden soil.

FIG. 67.—Some of the water used in washing lettuce was added to this plate of agar; the above indicates the need for thorough washing of such vegetables.

The Icebox.—The icebox, too, has its problems. If old (and most people economize on the kitchen and its equipment more than elsewhere), it may have much wet, musty wood in it. Broken tops or doors carelessly left open raise the temperature. To "save ice," newspapers are sometimes wrapped about the ice, ignoring the fact that the inclosed air and food are cooled only as they give up their heat to melt the ice. It saves ice, but helps turn the icebox from a refrigerator into an incubator. Finding a favorable temperature, bacteria multiply rapidly in such substances as milk, and

we wonder "why it soured in the refrigerator." Most iceboxes do not provide a lower temperature than 10° C. (50° F.) and every effort should be made to keep it down to that temperature.

The ice chamber is a better place for milk bottles than the shelves, and it is wiser to cool the drinking water in similar bottles than to put ice into the water.

Many foods absorb odors; milk and butter are affected by turnips, strawberries, bananas, etc. It may be necessary to guard against such odors as well as the musty odors of old food or water-soaked wood or icebox linings.

Water Coolers.—The best water coolers have separate compartments for the ice, so that the careless handling by icemen is a matter of less concern. If ice ever comes in contact with the foods (salads, cooling drinks) one should make sure that the effects of handling (manure, soiled hands, dragging over dirty pavements) are washed off as well as can be done before the ice is put into the refrigerator. It is very difficult, but very important, to secure such coöperation in kitchen and delivery service. Most water coolers have a very short faucet, or a leaky faucet (Fig 87), making it difficult to secure a glass of water free from finger-washed drippings (see p. 278). A common cup should not be provided, even if the members of the household are all free from Riggs disease of the teeth and gums, venereal disease, and intestinal diseases, for common colds are too easily spread in that way to make it desirable to continue the common drinking cup in the home.

House Filters.—House filters, as described in the chapter on water, are usually worse than useless. The kind of care house filters usually receive makes inadvisable the use of any but a cotton pad filter. The pad is renewed at least once a day (see Chapter V).

Plumbing.—The bathroom and kitchen nowadays share that mysterious blessing, "modern plumbing." When one makes a mystery of such simple facts as "heated water rises," or such simple mechanical principles as the siphon, modern plumbing is indeed hard to understand.

Every user of modern plumbing should understand the main features of its use in our homes. There are two distinct parts: (1) the incoming water system delivering hot and cold water at the various faucets; and (2) the outgoing pipes containing water and the more or less liquid waste from the kitchen, bathroom, and

laundry. Open plumbing, that is, plumbing exposed to view, is most desirable for the following reasons: better workmanship is usually received, leaks are more promptly detected, and repairs are both simpler and less expensive. If the plumbing is in recesses, the protecting woodwork should be screwed instead of nailed in place, or otherwise easily removed. The dark plumbing recesses are usually moist, and make hiding places for insect pests.

The Water System.—Beyond the fact that the water pipes may open out into special tanks—storage tank on the roof to insure good pressures at all levels throughout the house, the toilet tanks to insure a sufficient amount of water for flushing purposes, the hot-water boiler holding water which becomes heated because the pipe feeding the boiler passes first through the furnace or over a gas flame—there is little in the water service that is difficult to understand. The main problems are leaky faucets, leaky joints, and frozen pipes. The first two lead to loss of water, water-soaked corners or floors, or damp cellars, and usually demand the services of a plumber, though there is now a type of water faucet that can be repaired by a non-expert.

Frozen Pipes.—Frozen pipes do not always burst. Moderate general heat should be applied by wet cloths on the pipes, or oil stoves or even lamps should be placed near by. Do not apply concentrated heat, such as a flame, at one point, but with wet cloths thaw the faucet, and work back and down until you have reached the source of the trouble. Leave the faucet open to allow the expanding water to escape that way, or the pipes may burst. (Cold water expands as it nears the freezing point, 4° to 0° C. (39° to 32° F.) So there are two chances for your water pipes to burst: one as they freeze, and one as they thaw and the water becomes warmed. If possible, gradually raise the temperature of the room or cellar where the freezing occurred, so as to prevent extension of the frozen area. Frozen pipes [2] can generally be cared for without a plumber. When pipes freeze in one house, they are usually frozen in other houses, and plumbers are much in demand. Every member of the household, however, should know just where the water

[2] Frozen waste pipes burst less often than frozen water pipes. Waste pipes contain but little liquid material (traps, etc.), and as that freezes it finds the necessary room for expansion by compressing the elastic air which fills most of the pipe.

enters the house, so as to turn it off in any emergency, as in case of a leak or a broken pipe. There is little excuse for sitting in increasing floods of water while someone hunts for a plumber. Hot-water pipes freeze and burst more readily than cold-water pipes. This is due to the fact that there is more air in cold water than in heated water. Ice crystals form more slowly in water containing air.

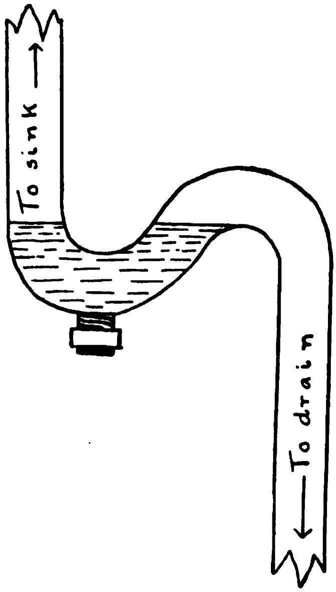


FIG. 68.—A simple trap, the S-trap. At the bottom of the curve is an opening through which grease, etc., can be removed. When water enters from the sink, a continuous column of water is formed; this siphons over, leaving the last of the water in the trap as a seal, as shown.

House Waste Systems.—The disposal system is more complicated than this, however. Every waste pipe from sink, bathtub, wash basins, toilets, and laundry tubs has in it one or more bends called traps (Fig. 74). These traps are of various styles (Figs. 68 and 69), but they are all designed to prevent the gases from the drains and sewers from coming up into the house. Where these outflow pipes enter a main or larger drain pipe, another trap is usually found to prevent any gas from that main pipe from coming back into the house. When all these outlets have been collected into

one large drain, another trap is usually found just as that drain leaves the house and empties into the sewer. So between the street sewer and any fixture there are often three traps.

The S-trap (Fig. 68) is the simplest kind, but of the several other types the commonest is the bell-trap (Fig. 69), often used in floor drains and in old-fashioned kitchen sinks. If the kitchen sink is not washed out after the dirty water passes from it, soiled water is left in the trap and odors from that soiled water may be noticed. In houses left for several months in summer the water

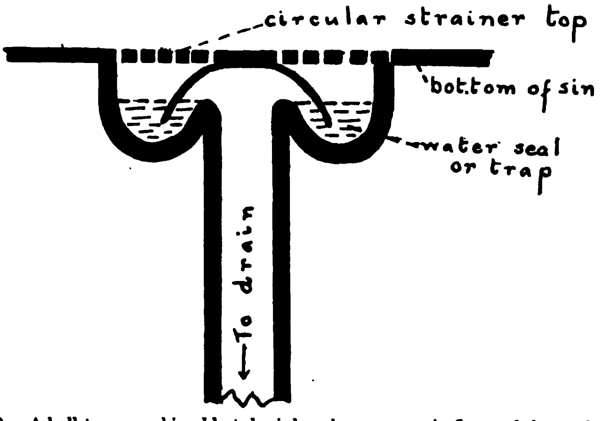


FIG. 69.—A bell-trap, used in old-style sinks, also common in floors of shower baths, garages, etc. The water seal is a circular area into which the circular edge of the bell-top fits.

in the traps may evaporate and allow odors to come back into the houses. Fixtures should be flushed periodically by the caretaker; or the trap can be preserved by a film of oil which spreads out readily on the surface, preventing evaporation. Glycerin might be used because of its water-holding power, which prevents evaporation, and may even attract water from the moist atmosphere.

Another difficulty with traps is that they may be thrown out of order (emptied, clogged) by foreign matter (Fig. 70). An opening is left in most traps through which they can be cleaned out (Fig. 68). Often valuable objects (*e.g.*, jewelry) washed down a waste pipe can be recovered from the trap. Opening the trap, though not pleasant, is not a difficult job, and does not necessarily demand the services of a plumber. Grease from the kitchen sink,

especially if cold, often fills up the curve. Accumulations of grease sufficient to clog a pipe may be due to carelessness and waste in the kitchen. Often, however, it is due to poor plumbing. If the main drain pipe, into which branch pipes empty, is too large, the

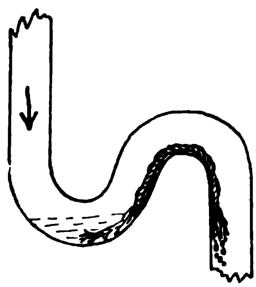


FIG. 70.—String, etc., catching in traps may carry the water over, until the water is too low to act as a seal; objectionable odors then pass back and up into the house.

flow is retarded by the friction which a relatively greater surface causes, and grease may be deposited; usually it is scraped off by the action of small particles in the moving current. If the main drain pipe is too small, passage is also retarded, and grease may

FIG. 71.

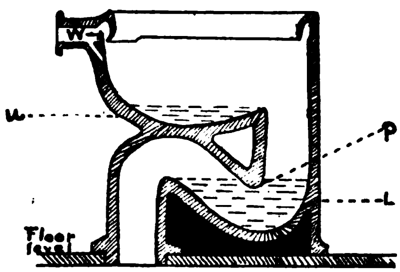


FIG. 72.

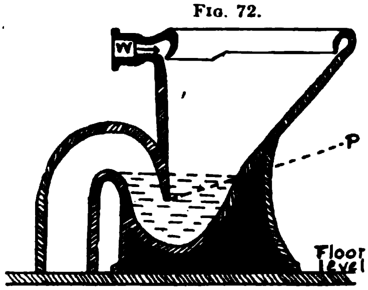


FIG. 71.—A "wash out" closet; the words "wash out" refer to the washing out of the bowl. The trap is made by the water below (L). If the point P is very short as shown here, the seal is not very good, and is "broken" if a little water evaporates, as in houses closed for the season.

FIG. 72.—A "wash down" closet; this has no upper chamber of water. The trap is better than in Fig. 71, because the point P is longer.

collect in the traps. Sal soda (1 part to 10 of water) may be used to clean out grease-retarded pipes. If this does not remove the difficulty, use lye or caustic soda, making a saturated (G) solution, and diluting with an equal amount of water; a pint to a quart

should be poured into the sink. The pipes should be flushed thoroughly with hot water afterward (as lye is a little "hard" on plumbing). With careful use house sinks may be used for years without ever having to have the grease trap opened.

Three types of water closets are shown here (Figs. 71, 72, and 73). Each contains a water seal; the differences lie chiefly in the method of flushing.

Traps and Sewer Gas.—Sewer gas is continually being formed in the sewage, and while we now know it cannot cause disease, such odors are unpleasant. To make sure that they do not break through

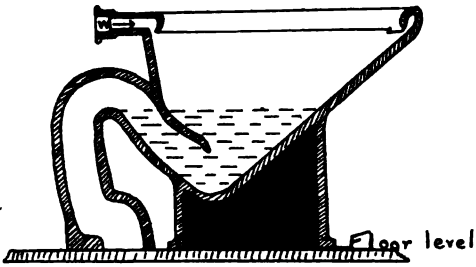


FIG. 73.—A "siphon closet" in which the siphon action is better, the little bend in the outflowing pipe slows the outflow, and both sides of the curved outflow pipe become filled with material, making a siphon which sucks out practically all of the original material, leaving only fresh clean water in the trap. The siphon action is more complete in such types.

the trap or water seal, a pipe leads off from the back of the toilet and from the back of the main house drain, into a special vent pipe that runs up through the house and opens one to two feet above the roof (Fig. 74). Any gases working back along a drain find it easier to go on up the vent pipe branch than to push through the water seal.

The practice of keeping a fine wire sieve in the kitchen sink to screen the vegetable water, etc., is a good one. There is no excuse, however, for the soggy brushes often seen there. If a brush is necessary for occasional cleaning of the sink, it should be dried thoroughly (outdoor sunshine or radiator) and kept dry until used again. It is much better to have a roll of paper towels hanging near the sink, using a couple of pieces to clean out particles of waste, preparatory to the final rinsing of the sink.

Bathroom: Care and Equipment.—Toilets should be kept clean and filled with the amount of water called for by the tank.

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It is not a good plan to lessen the tank outflow by bending the attachments in the tank, as the depth of the water in the bowl is adapted to the type of trap. Toilet traps are often hidden from sight, especially in some of the porcelain stands, but they are always present (Fig. 71). Outdoor privies will be treated under sewage disposal (also p. 251).

Colds, sore throat, grip and other infectious diseases are easily transferred by unclean faucet handles, doorknobs, toilet flush

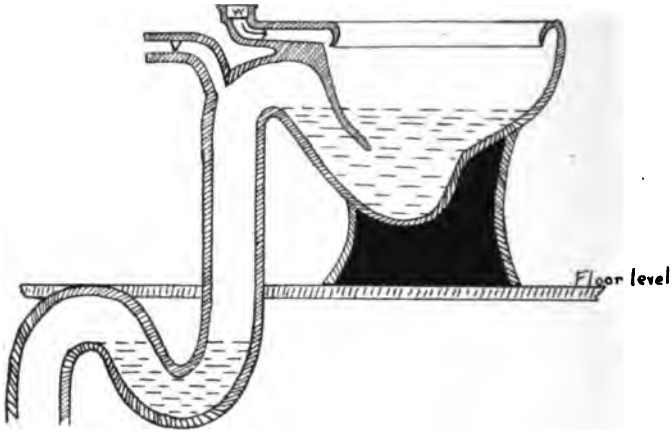

FIG. 74.—Closets may have a double trap, as shown here. The second (lower) trap slows the emptying process, and improves the siphonic action. This cut shows also the vent (v) customarily placed in traps to allow any back-pressing gases to escape into a special set of pipes (vent pipes) opening on the roof; since these air or vent pipes offer less resistance than the water in the traps, the gas escapes that way without "breaking the seal."

handles, and other bathroom fixtures. They should be regularly and frequently cleaned. Individual towels, wash cloths, and handkerchiefs should be supplied for each member of the family, no matter how young.[3] Squares of cheesecloth or old white goods, kept for colds and such emergencies, can be burned, thus eliminating washing. The frequent washing of hands should be made easy —with lavatories on each floor, for example, especially if there is

[3] Few who read this will realize, probably, how many people now living have never considered such things necessities, and how impossible a standard this is for many, many families. A world in which millions find it difficult and even impossible to escape hunger and cold will include more still who are never clean.

but one bathroom for the whole family. Paper towels will often tide over an emergency, when the prospect of an unusually large wash would make one choose the less desirable method of sharing towels. After washing, if one has a cold or sore throat, the bowl should be flushed with hot water, and a clean piece of paper used to turn the faucets, etc., that another well member of the family will soon touch. A little alcohol, ammonia, or other suitable disinfectant may well be rubbed over such attachments after use by one having a cold or sore throat (see p. 189).

The water closet itself is often quite a problem. Chance visitors to the bathroom may leave one quite uncomfortable as to the safety of the appliances used. Good soapsuds is a safe measure, but that sometimes may not be at hand. Kerosene or gasoline, if there is no free flame in the bathroom (*e.g.*, gas jet, oil heater) makes a good emergency wash that will not injure the finish on most seats. Boarding houses and hotels should have adjustable paper seats (cut newspaper will do) with a waste basket for receiving them.

Every effort should be made to have hotels and boarding houses substitute the sanitary shower for the bath tub, which too often is not properly cleaned before using. Serious infections have been traced to its use. Bath tubs should be thoroughly washed with hot soapy water, and rinsed with plenty of hot water[4] before they are used. The practice of having baths drawn by careless or infected servants is not without danger. To members of the same family there is usually little danger of disease transfer from the bath tub; too commonly, however, the one tub must be shared with others: servants, guests, and boarders. In such cases a shower bath is certainly preferable.

Bathrooms and toilets should be aired thoroughly, though the night temperatures should be such that no chill is felt by night visitors. The bathroom is often so poorly heated in winter that bathing becomes a moral issue. Everyone in charge of a home must make such provisions for personal cleanliness as are necessary for the health and general well-being of its members. At times, insistence as well as provision may be necessary. If the bathrooms are not comfortably warm, bathing may be too cursory or too infrequent; although we know now that bathing is not absolutely

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[4] Clean cloths are better for this purpose than the wet soggy brushes commonly used.

necessary for health, there are still strong arguments in its favor: bathing, especially if followed by a cold shower or plunge, has a stimulating effect upon the skin and improves its important function as a regulator of body temperature. It gives a sense of relaxation and rests the body more than any other process except massage. Not the least of its values is the sense of cleanliness and general well-being.

Methods of Cleaning.—The day of the feather duster has passed, but not all of the dust-raising processes have shared the same fate, unfortunately. Lint-producing carpets are still too com-

FIG. 75.—Plates were exposed for five minutes each in a room following the type of sweeping or cleaning indicated below each plate.

mon; so is dry sweeping (Fig. 75). The dry dust cloth is still used unquestioningly by many (Fig. 76). True, the stores advertise dustless dust cloths, but they are fairly expensive, and used for far too long a period without replacement or washing. It would be much better to saturate old rags with a little water, a little kerosene, or a little furniture polish (whichever the type of articles to be dusted demands), and make a number of dustless cloths which could be used and washed often—daily, and dried thoroughly in the sun (or on rainy days near the furnace or range). Rugs not only have a less lint-producing surface than carpets, but they are more easily handled, and consequently aired and cleaned oftener. The carpetless edges and corners of the room show the dust more

promptly than if covered with carpet, but it is easily removed and is removed oftener and more completely than from carpets. A little more attention might well be paid to the dust- or lint-making character of the materials used for floor coverings.

The vacuum cleaner (Fig. 75) should replace the broom whenever the family income makes it possible. Efficient daily and weekly cleaning with such aids makes the yearly turmoil called spring housecleaning unnecessary, except as a stimulus for discarding accumulations of useless materials.

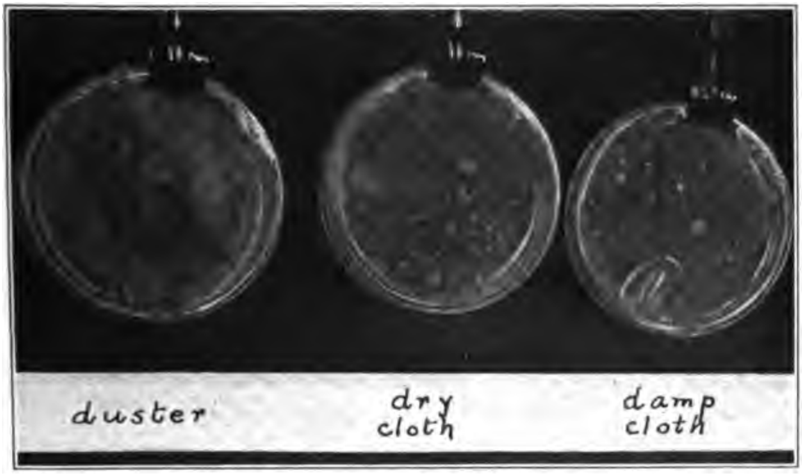

FIG. 76.—Dusting by three different methods as indicated.

Floors.—In cleaning floors a clean cloth slightly moistened with kerosene (or a more inert oil) should be used occasionally to remove dirt, if water is harmful to the type of floor. Water in small amounts can often be used safely, if removed quickly and thoroughly. Oil and wax tend to hold dust and lint, and keep the air less loaded with such suspensions. It is, nevertheless, desirable occasionally to clean or even scrape such coated floors and start afresh.

Dishes.—The cleaning of dishes is often most incompletely done. Soapless, dirty dishwater is most common. Scraps should be removed from the plates before the dishes are put into the dish-

pan. Rinsing at the faucet, to remove such material, is a good plan. If running water is not available or limited in amount, the plates should be carefully scraped or even wiped with bits of paper. This not only keeps the dishwater in better condition, but removes grease, etc., that might clog the drains. There is no excuse for washing dishes in water that suggests garbage. A lather is necessary to completely remove the bits of food or mucus from the dishes. There is every reason why glasses and silver should be as thoroughly washed in soapy water and rinsed in very hot water as any other dishes; more so, because they come more directly into contact with the mouth than anything else, except the teacups and spoons. It is a very common practice to treat dishes that look clean, *e.g.*, drinking glasses, as if they were clean, rinsing them without washing. Just as objectionable is the habit of never rinsing the glasses at all. We wash dishes, rubbing especially soiled parts (edges of glasses) to loosen saliva and food particles from them, but even so, rinsing is always necessary. Wash water and rinsing water should both be changed often, if the number of dishes is large; neither should be used when it is dirtier than the dishes put into it. Many times dishes (such as teapots) are dirtier after they have been washed than they were before.

Dish Cloths and Towels.—Dish cloths and dish towels should be clean and fresh smelling and washed often, preferably after each meal. If a sufficient number of dish towels are in use, and they are dried thoroughly after using, once a day may be sufficient. Dish cloths should never be left in a wet ball or wad in the sink or hung in a dark place (*e.g.*, under the sink), but they should be washed and rinsed as thoroughly as the towels and dried after every meal. If dish mops are necessary because of the sensitiveness of the washer's hands to water, more than one mop should be provided, and they should be washed and rinsed thoroughly, and opened out while drying so that the sun can penetrate the threads.

Pans and Kettles.—Sufficiently soapy water will not leave a rim of black grease on the dishpan. A dishpan should be as clean as any other pan, and should be as useful in any emergency (*e.g.*, washing lettuce) as any other pan. The only reason (except convenient size) for using a dishpan for dishes *only* is that it is too dirty for other purposes, which is in itself an admission we should be loth to make. Pots, pans, and kettles should be as clean as the

dishes, and washed and rinsed as thoroughly. Where wood or kerosene is used for fuel, such utensils become blackened on the outer surfaces, but the inside should be as clean as any dish used on the table.

Personal Articles.—Handkerchiefs, towels, etc., of the members of the family suffering from any contagious disease (cold, sore throat, grip, measles) should be boiled in soapy water before they are handled by the one doing the washing. Washing in hot, soapy water, and the subsequent boiling, followed by drying in the air and sun, render clothes not only clean but safe. Ironing is also of value in killing any objectionable organisms. Clothes washed away from home are often not boiled at all, and too often in bad weather they are dried indoors. If infected members of the laundress's family help in the later processes (*e.g.,* folding the ironed clothes), there is a little danger that tubercular or venereal infections, if present, may be transferred. There is no reason to think that disease organisms survive thorough washing and drying in the sun. Ironing kills undesirable bacteria, but it is done for appearance mainly; where time and money are a real consideration, it would be better to dispense with ironing for many articles and expend that time or money in securing better washing conditions and results (see p. 280). The clean, attractive odor of sun-dried sheets is really not improved by the subsequent dampening and ironing.

House Disinfectants.—Under cleaning no disinfectants were given for the treatment of the sink and toilet. Soap, good clean water, air, and sunshine are all that good plumbing needs. Sour, musty or foul odors indicate leaks or breaks, and demand the immediate services of a plumber. A deodorizer would but hide the real condition temporarily and give a false idea of security.

Disinfection during and after sickness is treated in a separate chapter (see Chapter X); dishes and other objects coming in contact with infected people should be treated as described in that same chapter (see Appendix).

Insect Pests.—Insects are often found in the home. No housekeeper publishes abroad the fact that vermin infested the beds and clothing, and sometime we will wage as earnest a warfare against flies, croton bugs, and sow—or pill—bugs as against bedbugs. Their presence usually indicates unsanitary conditions (food accumulations, wet or moldy woodwork), and may lead to the trans-

fer of disease organisms (typhoid, fly; tuberculosis (?), bedbug) (see Appendix).

Household Pets.—Pets in the household are difficult to discuss adequately. Rabbits, chickens, and similar pets kept outdoors, and birds rarely have diseases transferable to man. They are handled less than such indoor pets as cats and dogs, and hands are more likely to be washed before eating, etc., so that there is little objection to such pets, if their quarters are kept free from objectionable odors and accumulations. With dogs and cats, most intimate indoor companions usually, the situation is very different. Both cats and dogs are susceptible to whooping cough; cats have been known to carry diphtheria in their throats; dogs harbor a tapeworm and several less common worms transferable to man. Their proneness to haunt accumulations of refuse and offal, and their intimate association with the household inmates, nosing the food, licking the hands, stepping or lying on cushions, beds, etc., make such direct transfer unpleasant in idea if not actually elements of danger. While there is less danger in drinking after a dog than a human afflicted with venereal disease, it is not a necessary alternative, and should not be presented as such. The danger from rabies is not slight, and every one owes it to the community so to control his dog (muzzling, confining to enclosed yard) that he does not add to the disgraceful prevalence of rabies in this country. Other countries (England, Australia) have practically stamped out rabies and demand a long quarantine period—several months—of any dogs brought into their countries. We ought to have a nation-wide law requiring muzzling of *all* dogs for two years; after that a strict quarantine law on imported dogs would be sufficient.

It is rare nowadays that dogs or cats perform any real service (mice, rats) not more efficiently and cheaply done by traps, poisons, etc.; cats yearly destroy more insect-destroying birds than their mousing records can balance.

It is time to look this matter squarely in the face, and admit (1) that our insistence upon dogs and cats as pets is mainly a matter of personal pleasure, for we enjoy the feeling of companionship and the grateful recognition of mastery and benefits bestowed; and (2) that these sensations would be equally satisfied if otherwise homeless children took the place of dogs and cats. Only a very selfish person can support the claims of dogs and cats against those of children.

PROBLEMS

1. Describe the daily cleaning methods in use in your home. The methods in use in your church? Give their good and bad points.

2. Is money or thought more necessary in improving your home methods of floor cleaning? Dish washing? Dusting? Calculate the extra time or extra money (*e.g.*, soaps) it would take per week or month to perform one of the home cleaning processes in a way you would like to have adopted.

3. The statement is often made, "It costs money to be clean." How much does it cost per year for soap, hot water, scrubbing brushes, towels, etc., for each person in your family?

4. What is the relative hygienic importance of (1) fresh air, (2) dustless rooms, and (3) hygienic handling of food and dishes? Which receives the greater emphasis in your home? The least? Illustrate by the type of person performing the related tasks, the time devoted to each, and the actual cost (apparatus, utensils, etc.).

5. There is probably very little danger in eating food that has dropped on the floor. The organisms thus picked up are unlikely to be harmful ones. Often such disadvantages may be wholly overcome; *e.g.*, by washing, cutting off outer surfaces, or by heating or cooking (toasting bread). Show why it may be dangerous to eat candy carried loosely in the handkerchief pocket of another; or to lay one's tooth brush on the edge of the wash basin used by others in the same boarding house.

6. What provisions regarding racks for towels, wash cloths, tooth brushes and soap should be made in boarding houses, if the members use a common bathroom? Show that nails and extra shelves, for temporary placing of glasses, soap, cups, etc., and a paper towel supply are absolutely necessary for all with instincts of personal cleanliness.

7. Modify the following to make it suitable for your home. It should state plainly, but without undue offence, the necessary rules or recommendations.

UNPLEASANT TRUTHS FOR COOKS AND WAITRESSES

Do you realize that one little unconscious personal habit may completely destroy all pleasure in the meals you take such pains to prepare and serve?

Would you like your cook or waitress to put her tasting spoon or fork back into the food?

Would you keep her if you knew that when she prepared salad or cut up fruit she licked her fingers instead of wiping or washing them?

Would you enjoy having her cough constantly into your food? Wipe your soft-boiled eggs on used napkins? Touch the drinking edge of your glass with fingers that have handled soiled handkerchiefs or other articles of clothing?

Sore throats, colds, diseases of the teeth and gums, dysentery and typhoid may be conveyed in this way. Fully as important is the esthetic aspect. Why spend so much time making food look attractive (fancy molds, designs, etc.) when one careless habit may render it all absolutely repulsive to an observant person?

See Reference List at end of Appendix.

CHAPTER XIV

SUMMER CAMPS

In the main, the health problems of the summer camp are those of the ordinary home. This is true whether the camp is a tent, a "shack," an isolated permanent cottage, or part of a summer community.

Camps need all the safeguards mentioned in Chapter XIII. Most important, also, are the source of the water, the restricted range in food materials, the greater danger from insect pests, and the disposal of garbage and human waste.

Water.—In mountainous and isolated regions the water supply may sometimes be safely taken from brooks or streams. But the dangers of pollution by hunters, mountain parties, etc., must be considered, and only cistern, spring, or well water should be used, unless the surface water is chemically treated or boiled (see Appendix.) Lake water is too often used for drinking by campers, even though that same lake serves also for bathing, and as a receptacle for the house drainage. Sufficient dilution and the other factors mentioned in the chapter on water may make such water comparatively safe, but it is hardly a pleasant conception.

The numbers sometimes represented in boys' or girls' camps or overcrowded summer resorts often make it extremely unlikely that surface water—even when taken a number of miles upstream—is safe from human pollution.

To fill the general demand for opportunities for swimming, lakes or streams far from safe often determine the site of the camp. Most State boards of health will pass upon such conditions for prospective members or managers.

Disposal of Waste.—The disposal of waste is also quite a problem. A wire basket in the upper part of the fireplace may dry out green garbage so that it can readily be burned, or a wire basket may be used outdoors as an incinerator. Materials in it would dry

out fairly well if not too tightly packed; a little kerosene would insure quite complete combustion. In localities not too closely populated nor too rocky garbage can be buried.

Toilets.—The toilet offers the most difficulty, usually. If soft earth or ashes are available, a dirt closet is perhaps the best cheap way of solving the problem. The receiving vault should, of course, be fly-proof, and emptied whenever necessary; lime may be used as a deodorizer, mixing it with the earth; if sufficient earth be used, lime is unnecessary. The vault should have a screened area below the seat level to help in ventilation. Pail closets are described on page 149; see Chapter VII for other methods of sewage disposal.

If the camp is a house—not a tent—the rainwater can be collected and used for laundry and toilet-flushing purposes. The great tendency to save on water for cleaning purposes generally, if water must be carried, makes a cistern (if mosquito-proof) an invaluable addition to the summer camp. Cement work is so easily done that almost any man can construct a satisfactory cistern; wooden tanks probably offer more difficulties to the amateur. Simple ingenious devices, such as using an ordinary garden hose between the tank and the privy tank, give the summer resident a water closet at a nominal expense.

Food.—The restricted range in food materials may be a great drawback to certain camp sites. Milk is unobtainable in some sections; clean, safe milk not common in most. Green vegetables are often very scarce. Housekeepers with prejudices against canned goods, or who go away for the summer to economize, often provide most insufficient dietaries for their families, especially the children. This is one of the criticisms oftenest made against camps for boys and girls; while explainable, as they are usually money-making organizations, it indicates a lack of proper supervision on the part of the parents, who should consider the dietary provisions as seriously as those for amusement and recreation.

Insect Pests.—The danger from insect pests is, of course, mainly from flies and mosquitoes (Fig. 77 and 78). The inadequate methods of disposing of human wastes afford opportunity for typhoid transmission; the relatively small number of people make malaria transmission quite frequent, if malarial persons are also residents of that same area. The longer periods spent in the open,

and the difficulty in completely screening tents add greatly to the opportunities for disease transfer (see Appendix).

FIG. 77.—The fly menace.

General Warning.—All the cleanly and preventive measures desirable at home must be emphasized here, for there is a great tendency to "let down" on all the sanitary customs, trusting "country air" or some other influence equally vague.

FIG. 78.—Lessons for the housekeeper and camper.

PROBLEMS

1. Make a set of health rules for a camp of girls 14 to 17 years old; for boys 10 to 14 years old.

2. What three fundamental health or sanitation standards would you demand for a camp of berry pickers who are housed and fed on the fruit farm?

3. What are the sanitary requirements you would have in mind in buying ground for a permanent summer camp?

4. What are the sanitary provisions one should make in planning a canoe trip down a river?

5. One American city conducts a municipal camp open successively to various groups of people: young working women, family groups, and young men. If you were responsible for the sanitary policy what points would you emphasize for all three groups? What differences might be advisable or safe?

6. What is the best method of disposing of garbage in summer camps (see Chapter VIII)?

7. Write a short article on drinking water (standards, dangers, and treatment) that your local paper could use to influence people in making their vacation plans.

8. Support the statements and implications in Fig. 78 by definite facts.

See Reference List at end of Appendix.

CHAPTER XV

SCHOOLS

While most of the material presented in this chapter is applicable to large school buildings as well as small houses, no attempt is made to include such topics as the complicated systems of heating and ventilation found in large schools only. The chapter on the home includes an elementary discussion of heating, lighting, and ventilation that should be read by teachers; more on these and related topics is to be found in the chapters on air and ventilation, sewage disposal and infant welfare; the chapters on transfer of disease and disinfection and quarantine should be read by all teachers, and those who do not realize that "the whole child goes to school" should include the functions of food in the body. Most helpful, also, even to city teachers, are the pamphlets on Minimum Health Requirements for Rural Schools and on Minimum Health Essentials for Rural School Children, listed in the Appendix.

Health Responsibilities of Teachers.—The day is past when even a poor teacher feels she has discharged her full duty when she has attended to the mental development of her charges. But while every teacher recognizes the need of preventing the transfer of such serious diseases as diphtheria, there is too often a lack of comprehension of the real nature of such insidious diseases as tuberculosis, of the attending evils of such common disease as colds, sore throats, and "grip," and in some localities a disgraceful apathy to such local diseases as malaria and hookworm.

Prevention of Disease by Special Treatment.—In such circumstances, compulsory education may mean compulsory contraction of disease. Scientific precautions should be taken to prevent such transfer of disease. Smallpox should be prevented by vaccination—before the little child first enters school and again before high school is begun. The prevention of diphtheria is now possible by the injection of the modified toxin recently advocated, though antitoxin is still used in such emergencies as epidemics (p. 206).

Epidemics.—Epidemics, such as diphtheria and measles, may be prevented by prompt exclusion of the affected, or by closing the schools for the usual incubation period of the disease. By that time those who have contracted the disease from first cases can be detected, and the well can be allowed to return to school. See chart (Fig. 49) opposite page 186 for rules concerning exclusion from school. If the epidemic spreads despite the closing of the schools, the spread is due to some other factor, such as milk or healthy carriers; this cause should be determined and eliminated. It is, of course, of little use to close the school, if the children are still intimately associated in playground, Sunday school, or settlement classes (see p. 184).

Carriers.—In diseases often spread by healthy carriers, such as diphtheria, or where the beginning symptoms are pronounced, as in measles, it is often better to continue the schools, examining the children as they appear on the school grounds (not allowing close contact) and excluding all suspects. In diphtheria, microscopic examination of the throats, especially the throats of those in close contact with the early cases, will enable the inspector to eliminate those who are carriers, as well as those coming down with the disease (p. 213).

Hygienic Relations of Equipment.—The school control of such diseases as common colds and grip, which are not always considered sufficient cause for exclusion, etc., is more difficult. In this connection the teacher should study carefully the tables on transfer of disease (pp. 173, 174 and the chart opposite p. 186). School equipment, such as drinking cups, may convey infection. Wherever possible the equipment should be individual, *e.g.*, pencils, books, and towels. Articles necessarily used in common should be of the type least likely to convey infection (smooth surfaces, washable, etc.). Water closets or privies should be so constructed that splashing does not occur, the seats should be U-shaped, so that unnecessary contact of sensitive surfaces is avoided. Basins, etc., should be kept clean. While surfaces which seem clean may carry infectious organisms, surfaces which are visually soiled or sticky are most likely to do so. Hands are preferably washed under running water, not in a soiled basin. Drinking fountains should be substituted for common drinking cups, unless it is possible to have individual cups and make sure their use is limited to the individual

owner. Some drinking fountains are as bad as the common drinking cup. Even good types are dangerous, unless a good flow of water is assured, sufficient to wash off the deposits left by the last drinker. Drinking fountains on the upper floors where the flow is very low may retain organisms for hours. The best types are, therefore, those which do not allow the mouth to touch the metal and which do not allow water once in contact with the mouth to settle back on the fountain (Fig. 79). In fountains having a vertical flow bac-

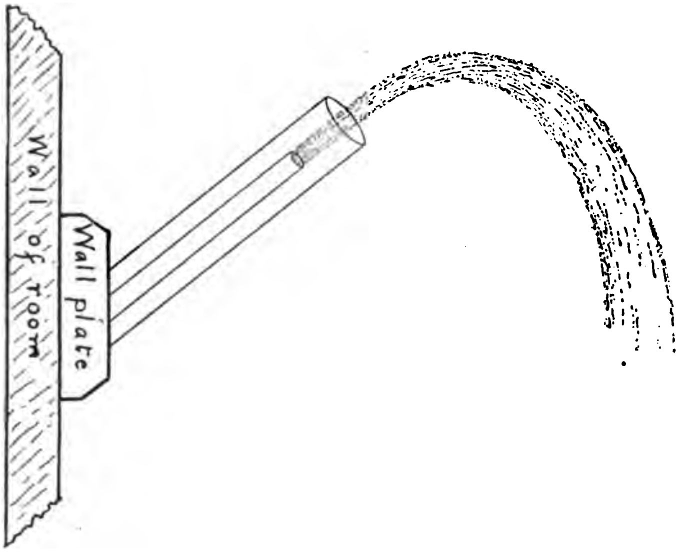

FIG. 79.—Water fountain in which one should drink from the curve of the water current. Even if the outer tube is accidentally soiled, the inner water tube is protected.

teria may be kept rising and falling in the jet of water, just as a ball is sometimes kept playing in the ornamental fountains of gardens and lawns.

There are many other factors or situations that interfere directly with the mental progress of the pupil and which predispose to disease. These situations or conditions include such widely varying factors as inadequate lighting, heating, and ventilation, incorrect posture, and definite physical defects, such as adenoids. We will discuss first important points concerning the building and its equip-

ment, and then the physical defects of the pupils which should be corrected, or at least considered in the educational scheme.

Location and Grounds.—The building should be easily accessible to most of the children attending, unless a school conveyance is provided for children who would otherwise have to walk too far. Conveyance for the winter months or stormy days could be provided in many localities at small cost, as such conditions often interfere with the use of horses on farms, etc.

The question of ornamental grounds versus playgrounds often has to be decided. In some localities it is wrong to take space for ornamental planting that ought to be given to playground space. A minimum of thirty square feet for each child is strongly recommended. If the area available is much less, ornamental planting should be planned to get the most effective results with a minimum area (borders, corners, etc.); the recess and even the beginning and closing hours should be adjusted to meet such space handicaps.

The building should be in as quiet a place as the distribution of the pupils will allow. Too often schools are thoughtlessly placed on any undesirable strip of ground, and the pupils are sometimes constantly subjected to objectionable smoke or gases or to interminable noises. The effect upon the nerves can be seen in the tense expression of teacher and pupils and in the irritated frown that involuntarily accompanies marked or sudden increases in outside noise. The effect upon the speaking voice is most unfortunate. The school should be a place of quiet, for there is no reason for thinking that only adults can work better in a quiet atmosphere. Such objectionable environments often make it necessary to keep the windows closed, and interfere with the proper ventilation of the schoolroom.

Lighting.—Ordinarily the window space should be one-sixth to one-quarter the floor space. In long rooms with windows at the end only, this must be decidedly increased. The proximity of other buildings would make similar increases necessary. Lighting must be judged by the amount available in the poorest seat in the room on cloudy or dull days. If the windows are high, the light penetrates farther into the room, for one-third of the light enters through the upper third of the window. Shades, therefore, should be fastened in the middle or at the bottom to enable the teacher to modify the light without unduly darkening the darker parts of the

room. The shades and walls should be of some soft, dull color, the shades preferably greenish and quite opaque. The light should come from the back or the sides of the room, preferably from the left side.

Heating.—Small schools are usually heated by stoves placed in the room. (See the chapter on The Home for types of heating and ventilation.) The thermometer should be kept at the "breathing line," and should never exceed 20° C. (68° F.); lower temperature is considered advisable by many (see Temperature, Chapter VI). The even distribution of heat throughout the room is much more important in schools than in a house where greater freedom of movement is possible.

The jacketed stove (Fig. 80) is advocated for rooms where children sit in fixed seats at varying distances from the source of heat. Sufficient oxygen for fuel combustion and a safe margin for the occupants is insured by a definite air intake, which is really very easy to construct. A little opening in the side wall can have a small pipe inserted in winter time opening directly into the room above the floor. This can be closed by a grated or shutter-like "register" when not in use. In the illustration the intake pipe opens directly under the stove.

The jacketed-stove system must have the used air removed from the bottom of the room, thus drawing the warm air down to the colder floor levels. For this, an opening into the stovepipe is necessary, connecting the used floor air of the room (outside the screen) with the stovepipe; the upward rush in the stovepipe carries the used room air with it. Two improvements might be made to the usual arrangement: (1) Placing the stove some distance out into the room so that the opening for used air will be farther from the stove and so insure a more complete mixing of the warmed air with the general room air. (2) The second is using a screen to deflect some of the heated air down to the colder floor level where we really live, and toward parts of the room not so directly in the warm descending current. Such a shield would be unsightly, and give an added area for dust collection. But on these points little can be said in favor of stoves and stovepipes generally. Additional window ventilation does not interfere with this method of heating and ventilating.

Inadequate ventilation is a common fault of the schoolroom.

Each child should have 2000 cubic feet of fresh air hourly; to avoid too great drafts in the displacing of the used air, a minimum room space of 240 cubic feet is recommended. If inlets and outlets are on the same side of the room, a better mixture of the air is

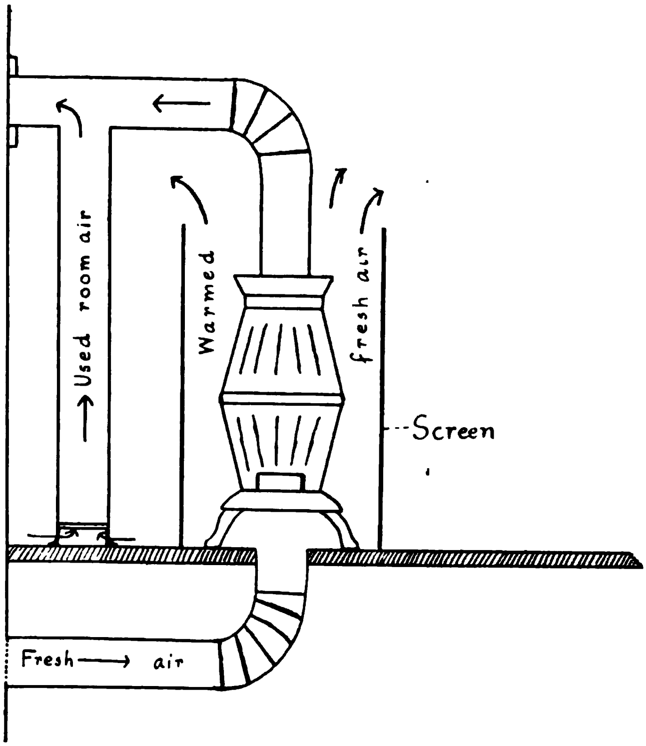

FIG. 80.—Jacketed stove; the fresh air inlet may be cut through the wall directly. A *floor* inlet is better when the stove is some distance from the outside wall. Notice that the outlet for used air connects with the stovepipe; this helps draw out the used air.

effected, especially if the heated air is admitted at least seven feet above the floor and the used air is taken out at the floor level (Fig. 34). These openings should be adequate, about sixteen to twenty square inches for each child (if no special pumping or exhaust system is used).

Window Ventilation.—Window ventilation is valuable, if the

teacher can be trusted to attend to it properly. Special ventilators can be placed in the windows to shut off drafts. Where radiators are used, the radiator can be placed under the window to insure the heating of the entering air, thus avoiding a chill. Usually, window ventilation may be combined with the heating or ventilating system employed, and periodical flushing of the room with fresh outdoor air by wide-open windows is most desirable. Schoolrooms should be aired in the unused periods; yet usually the last thing the teacher does on leaving the room for the night is to close the windows. Storms must be considered, but a little planning would make it possible to air schoolrooms over night and over week ends without too much danger from rains, cold snaps, etc.

Recently a study was made in New York City of over 5000 children eight to eleven years old, representing three different types of ventilation: (*a*) ventilation by open windows, room temperature ranging from 10° to 16° C. (50° to 60° F.); (*b*) window ventilation (often with deflectors to avoid drafts), with temperature ranging from 16° to 21° C. (60° to 70° F.) averaging 20° C. (68° F); and (*c*) mechanically ventilated rooms with closed windows, the temperature averaging 17° C. (63° F.) here also. The results, judged (1) by the absences due to respiratory diseases, and (2) by the number of those attending though suffering from respiratory diseases (colds, etc.), for the fifty to seventy-day periods studied were in favor of the open-window ventilation. In the open-window room with the higher temperature the respiratory disease absences were 32 per cent. higher than in the open-window low temperature room; in the mechanically ventilated room they were 40 per cent. higher than in the open-window low temperature room.

The respiratory diseases occurring in those not too ill to attend school were found to be 70 per cent. higher in the open-window low temperature room than in the warmer open-window room. But in the closed-window room they were higher still, 98 per cent. higher. This, as is evident, is a strong argument for window ventilation, but for window ventilation without constant drafts.

Open-air Schools.—It must be remembered that the respiratory diseases which allowed the children to remain in attendance were not serious ones. There is, however, a general impression among teachers that outdoor and open-window schools are more favorable to general health than the above implies. The results of

FIG. 81.—Notice the types of screens in these fresh-air schoolrooms.

physical examinations of children during the school year justify the establishment of open-air schools or open-window classes, if proper clothing can be provided (Fig. 81).

Cloakrooms.—Cloakrooms and toilet rooms should be well ventilated. Many teachers prefer to have the cloakrooms entered only from the schoolroom, thus assuring full control; in such cases care must be taken to see that the ventilation scheme carries the cloakroom air out through separate openings—not into the schoolroom.

Cleaning.—The equipment should have surfaces that are easily cleaned and kept free from dust. Vacuum cleaning is preferable to sweeping and dusting; where they are employed dust should be avoided by dusting with moist or oiled dusters, and sweeping with moistened brushes or using wet sawdust or paper. (There is no excuse, of course, for re-using soiled sawdust.) Windows admit more light if clean. Dustless crayons should be used.

Seating.—The desks and chairs should be adapted to the child. Grooved or hollowed seats tend to lessen sliding forward in the seat and sitting too far up on the spine. The seats should vary in size in any given room; and these seats should be adjusted or changed at least twice a year to suit the growing child. The slant and relative height of the desk should provide the least eye strain and avoid undue bending or "hunching" of the shoulders. Usually the desk is best placed at one inch ahead of the front edge of the seat, and at a level with the elbows.

Personal Cleanliness.—In some localities shower baths should be provided for children not properly provided for at home. Warm water should be available for hand washing at least in the winter time. Tooth brush drills seem to be helpful. And attention should be given to inculcating clean personal habits, especially care of the nose, spitting, and keeping fingers in the mouth and nose (Fig. 82). Home habits are often most undesirable in these respects; we must also remember that "cleanliness is not instinctive and must be learned" (see p. 170).

Fatigue.—Even with the best equipment possible, children may be unduly fatigued by the school day. Excitability is one early symptom of fatigue, and teachers must not be misled by it. Fatigue due to overheated or poorly ventilated rooms is not to be excused. The relative length of the periods given to play and work, to stand-

Fig. 82.—Do you know any children who are not careful about these things?

ing and sitting exercises, is important in relation to fatigue, and in creating bad postures. A tired child neither stands nor sits well; this leads to defects which are far reaching in their physical effects; for example, a stooping sitting posture may cause eye defects, spinal curvature, or a cramped lung area and an overworked heart. Bad sitting positions do more harm than bad standing positions, because one sits more hours than one stands. Parents and teachers pay less attention to the sitting positions, however, because they attract less attention.

Food.—Proper feeding (warm midday lunches, a recess sandwich) may do much to lessen the fatigue of school life. Where malnutrition exists, this should be met by free or low-priced lunches, preferably warm ones. A census of fifteen cities in 1913 covering over 500,000 children indicated that at least 5 per cent. were undernourished. New York City's rate was 4 per cent.; Providence contained 11 per cent., and Louisville but ½ per cent. New York City tries to provide 400 to 500 calories (G) for three cents.

Physical Defects.—The extent of the physical defects common in school children is indicated by Fig. 105. Other investigators report for large numbers of children still higher percentages of defects; for example, 15 per cent. ear defects, 30 per cent. eye defects, and 24 per cent. enlarged glands.

The percentage of men rejected for defective teeth and eyes in the present war indicates that these defects remain uncorrected in great part. It is surprising how long eye defects remain unsuspected.[1] The effect of adenoids (Fig. 83) upon health and mental development as well as hearing is most remarkable (Chapter XXI). They cause not only slowing of mental processes, but often lead to truancy, incorrigibility and actually immoral actions. One investigation showed that 90 per cent. of the backward and unsuccessful had physical defects; 40 per cent. of these included marked enlargements of tonsils and adenoids. Too often the defects are not attended to; careless procrastination is the usual

[1] One little girl of seven who had labored under an unsuspected eye handicap for two years was finally examined for glasses. When the oculist fitted in the correct trial lenses, and the blurred letters became clear, she asked in surprise, "Do the letters look like that to everybody?" On being told that they did, she burst into tears in sheer excitement over thinking that now she, too, could tell the letters apart and wouldn't be stupid any more.

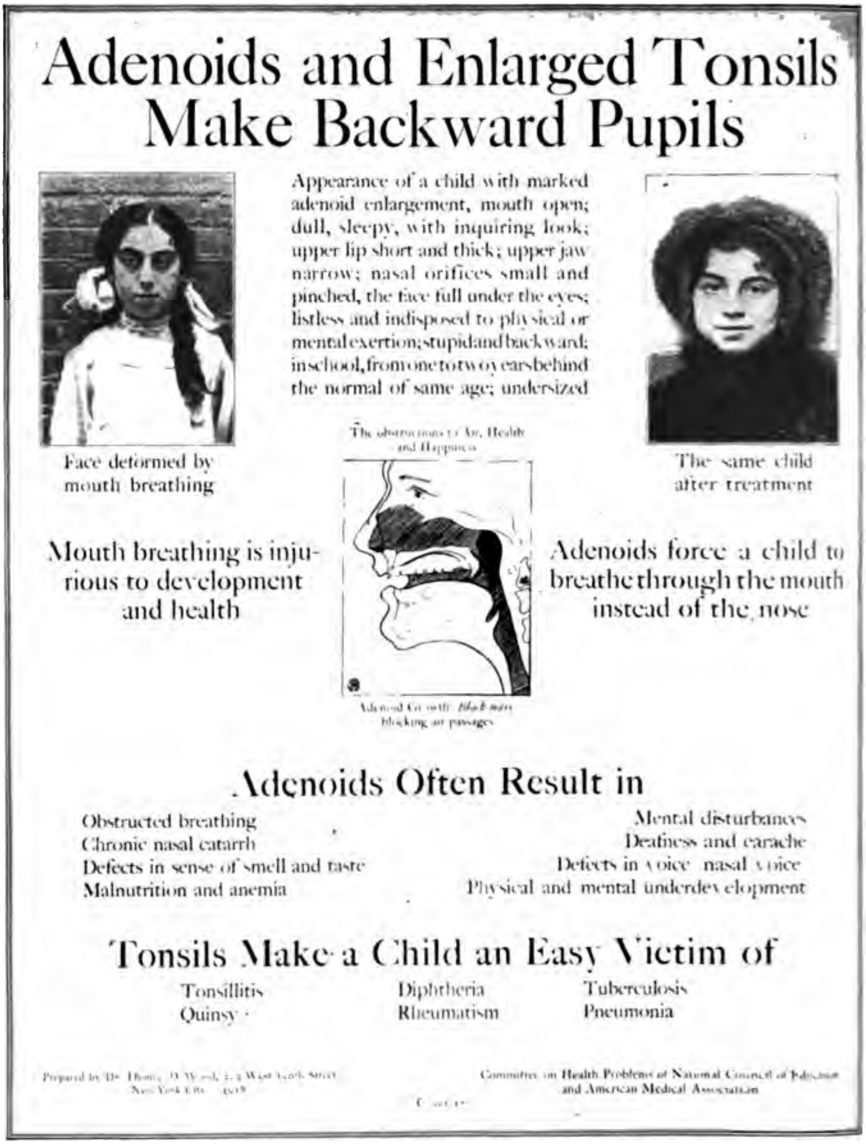

FIG. 83.—Do you know a mother or father who should see this chart?

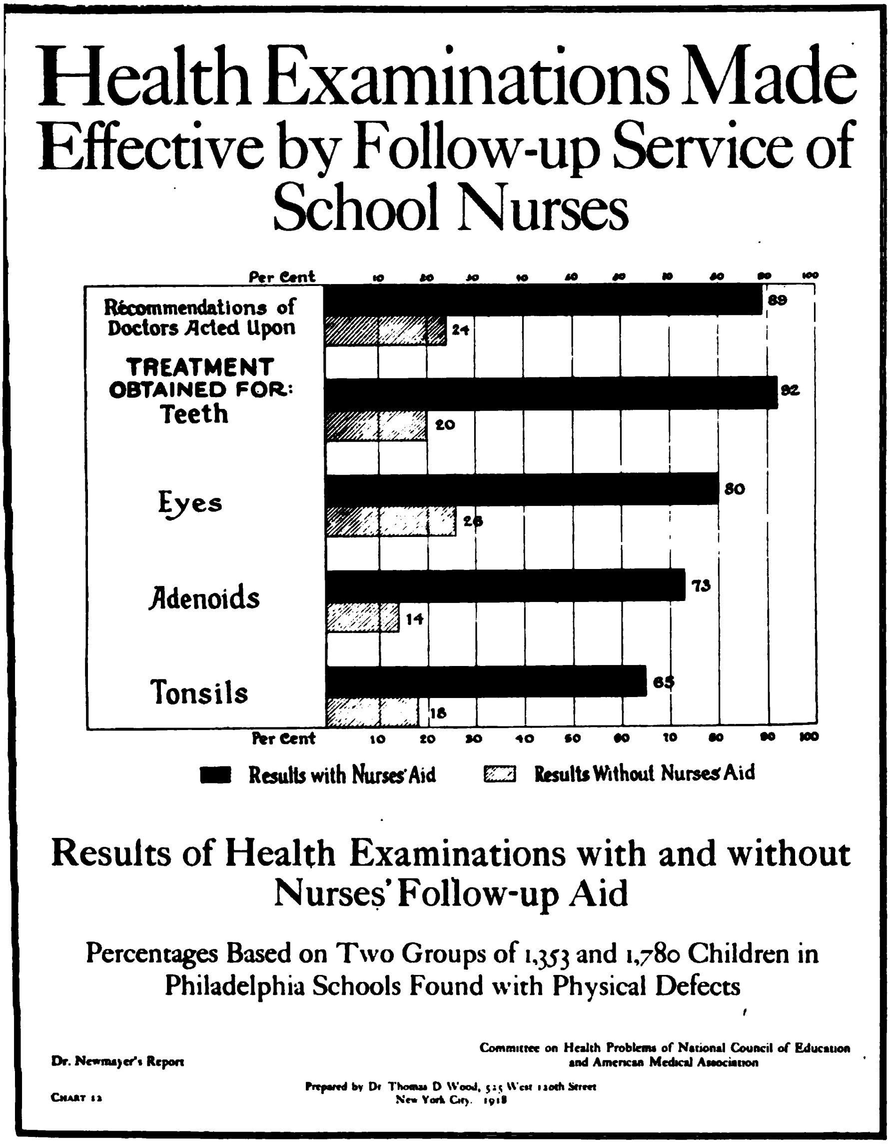

FIG. 84.—A strong argument for having school nurses.

reason, but often lack of money is the real reason. There are fortunately but few parents who, for sheer stubbornness or because of "the looks," refuse to provide glasses or other needed aids.

School Inspection.—While the regular teacher can detect many of the defects which interfere with a pupil's development, the services of a nurse are most valuable in emergency work, in diagnosing incipient disease, and still more, perhaps, for "follow-up" work in the home (Fig. 84). The services of more specifically trained people will be needed, however, for many conditions; *e.g.*, the type of eye defects, or nervous affection, or to decide authoritatively concerning operations for adenoids, etc. It has been shown that 75 to 90 per cent. of the defects are corrected when a school nurse or physician is employed, and but 15 to 25 per cent. where there is no trained nurse or adviser. Some schools have a rapid daily inspection by doctor, nurse or teacher to eliminate communicable diseases.

Each child should have a medical examination at least once a year, but twice a year is desirable: one in the fall to determine general fitness for school work, necessary corrective work (exercises, glasses, etc.); a second one in late spring or early summer may help determine the summer vacation plans. Reports should be filled out showing definitely the condition of the child, and the corrections most desirable (Fig. 85). Parents take more interest in such examinations, if they are invited to be present; and the examination can be more thorough (less clothing), if the parents are present. The following is a simple card which even a

	September Examination	Spring Examination	AVERAGE
Weight			lbs.
Height			in.
Girth of chest			in.
Girth of chest expanded			in.
Lung capacity			cu. in.
Strength, R. forearm			lbs.
Strength, L. forearm			lbs.

These averages are those for a person of your age and your height. The average height for a *boy* (*girl*) of your age is ....

HEALTH BLANK TO BE FILLED BY PARENTS

Date ....
Name of pupil...
Address ....Tel. No. ....
Name of parent or guardian...
Nationality of parents: F....................M...................
Date of birth of pupil.................Place of birth..................
No. of older brothers..................Older sisters.................
No. of younger brothers...............Younger sisters.............
Order of birth...
Health of child as babe..
Check any of the following conditions child may have suffered from and state year:
Diphtheria ....Complications......................
Scarlet Fever ....Complications { Ear............... Heart............. Kidney............
Measles ....Complications { Ear............... Lungs............. Heart............
German Measles ....
Chicken Pox..........Mumps..........Whooping Cough.............
Rheumatism ....Heart affections.................
Tonsillitis........................Frequent colds...................
Nervous conditions,................St. Vitus's Dance................
Accidents.........................Injuries ....
Operations { Adenoids .... Tonsils .... Rupture ....
Any permanent effect from these...................................

Name any other illnesses child has had.............................
....
....
....
What weaknesses or tendencies to ill health exist at present............
....
Does pupil keep the mouth open or lips apart during day or night......
....
Hour of going to bed................Hour of rising...............
Is sleep quiet or restless...
Is appetite good, medium or poor ....
Number of hours out of doors daily.................................
Favorite outdoor game or exercise..................................
Does child prefer outdoor games or reading for recreation.............
....
Average time for home study..
Studies or lessons taken out of school and time devoted to each.........
....
Habit of bowels..
Dates of successful vaccinations...................................
Date of last attempt at vaccination................................
Remarks: ....
....
....
....
....
....
....
....
....
....
....

FIG. 85.—Chart for supplying schools with helpful information regarding the children. How would such charts help in a school epidemic?

child can understand, and which shows general defects very clearly. A more detailed one is advisable for the school records (Fig. 85).

The first city to begin medical school inspection was Boston, in 1894. Now there are at least eighty cities with medical inspections, though some of these do not really deserve to be classed in this list; for instance, one has medical inspection every three years! Some of them provide free clinics for diagnosis and a few of them clinics for treatment. Of 100 cities, 77 reported one or more clinics; only 22 of these cities had school clinics, the other clinics being supported by hospitals or other organizations. Dental clinics were the most common, 59; next eye clinics, 28, and ear, 20, with psychological and general clinics numbering 16 and 14 respectively. Nose and throat clinics number but 8; orthopædic, 4; tuberculosis, 3; and 24 unclassified clinics bring the total for the 77 cities to but 176—not three apiece!

School Nurses.—Nurses are provided somewhat more generously. In 1916 one hundred of 121 cities reported school nurses. Some of these averaged but one nurse for from 3000 up to 8000 children. This proportion is most unwieldy, and diminishes greatly the efficiency of the work, and may so discredit it that it is a distinct setback to the whole movement. See the chapter on rural and city conditions (p. 351) for other phases of this problem of defects in school children.

Additional Considerations.—School inspection should include also an inspection of the school buildings, including such phases as the toilets, water supply, methods of cleaning, ventilating, and heating (Fig. 86).

An inspection of the teachers is also desirable; it would make possible the provision for leave of absence for needed rest or treatment, and the elimination of over-nervous teachers who continue to hold their positions because of pension or tenure-of-office rulings.

The intelligent really need no arguments for school inspection. It is the ignorant and the selfish taxpayers who need a health campaign to convince them that "it is folly to spend money on the education of children who are prevented by disease from becoming educated."

Ten Golden Rules of Health for School Children

1. Play hard and fair—be loyal to your team-mates and generous to your opponents

2. Eat slowly. Do not eat between meals. Chew food thoroughly. Never drink water when there is food in the mouth. Drink water several times during the day

3. Brush your teeth at least once a day. Rinse your mouth out well with water after each meal

4. Be sure your bowels move at least once each day

5. Keep clean—body, clothes and mind. Wash your hands always before eating. Take a warm bath with soap once or twice a week; a cool sponge (or shower) bath each morning before breakfast and rub your body to a glow with a rough towel

6. Try to keep your companions, especially young children, away from those who have contagious diseases

7. Use your handkerchief to cover a sneeze or cough and try to avoid coughing, sneezing, or blowing your nose in front of others

8. Study hard—and in study, work or play do your best

9. Sleep: Get as many hours in bed each night as this table indicates for your age. Keep windows in bedroom well open

HOURS OF SLEEP FOR DIFFERENT AGES

Age	Hours of Sleep
5 to 6	13
6 to 8	12
8 to 10	11½
10 to 12	11
12 to 14	10½
14 to 16	10
16 to 18	9½

10. Be cheerful, and do your best to keep your school and your home clean and attractive, and to make the world a better place to live in

Prepared by Dr Thomas D. Wood, 525 West 120th Street
New York City 1918

Committee on Health Problems of National Council of Education
and American Medical Association

CHART 32

FIG. 86.—Can you suggest an eleventh?

PROBLEMS

1. Make a set of health rules for the guidance of a grade teacher.
2. What polite habits or customs should a teacher endeavor to make habitual?
3. Name the nearest town which has a school nurse; medical inspection; eye, ear or teeth clinics.
4. Recall your own experience in other schools; in what ways were the health interests not sufficiently guarded?
5. Prepare an illustrated poster, a decorative set of rules, or a wall sign that will help children (of a given age) correct careless unhygienic habits.
6. Suggest ways of emphasizing personal cleanliness standards to children.
7. Grade one school, using the headings in this chapter for the main points of consideration.
8. What are the most needed changes in the school building with which you are connected?
9. How many of the problems given in the chapter on air can be used for this chapter?
10. How can you secure a school nurse or a medical inspector for your local school? Plan an exhibit to secure community interest and co-operation.

See Reference List at end of Appendix.

CHAPTER XVI

OTHER COMMUNITY UNITS OR RELATIONS

LIBRARIES, CHURCHES AND OTHER ASSEMBLY PLACES

Ventilation the Main Problem.—With libraries, lecture halls, and churches the main problems are those of ventilation. How incompletely such buildings are ventilated is illustrated by the difficulties experienced by a church in New Jersey some twenty years ago. Two furnaces with separate chimneys and heating systems were installed; but the janitor could never get more than one to burn at any time, though which one he could never tell until after he started the fires. The firm that installed the furnaces tinkered and adjusted, but without success. Finally a jack-of-all-trades in the neighborhood broke a pane of glass in the cellar window, and since then both furnaces can burn at the same time. Before that one furnace chimney was necessary to provide the fresh air for the other furnace. Too low chimneys (because of the architectural design used) may give similar trouble; each chimney should be at least two feet higher than the highest part of the roof.

Ventilation Standards.—In small localities such buildings are often open but once or twice a week. At such times they may be overcrowded; the ventilation usually falls far below the optimum standards advised by Kimball: (1) thirty feet of fresh air per occupant per minute; (2) no occupant more than twenty-five feet from a fresh-air register or nearer than six feet to a vent register; (3) at least one fresh-air and one vent opening to each thirty occupants. Instead of uniform conditions of this kind, people usually sit in overheated, stuffy rooms, which are closed tightly almost before they leave to remain closed until the next session, when the same used air is heated and used over again. The musty smell we associate with such buildings is not the "atmosphere of erudition" or "the odor of sanctity," but the odor of musty carpets, mildewed books, and stale air. The proneness to sleep during lectures and sermons is often less a criticism of the preacher and lecturer than of the ventilating system and its management.

Sunlight.—The stained-glass windows of our churches yield a

"dim religious light" that has certain restful and emotional values, but little germicidal power; in libraries the demand for shelf room limits unduly the space given to windows. The practice of keeping the shades down between periods of occupancy deprives such rooms of the beneficial effect of sunlight.

Library Books.—In libraries the question most often brought up is in regard to books. Tuberculosis may adhere to books, especially to the saliva-moistened thumbed areas. Examination of library books for mouth bacteria rarely shows streptococci in more than one in twenty books. This indicates disease transfer through books is not very great. Billings, a former medical officer of New York City, holds that 99 per cent. of the cases of communicable disease are transmitted from person to person, and almost never by fomites, such as books. Many libraries disregard the possible dangers from books entirely. School books, which are often more closely associated with communicable diseases, might profitably be disinfected before being used again. Standing them for a day or two on one end with leaves spread out loosely on an open window sill or porch in sunlight will probably weaken or kill off ordinary human organisms.

In New York City the health department passes on to the Public Library notifications of communicable diseases, and the addresses are compared with the out-book list at the libraries. Smallpox books are collected by the health department and burned; diphtheria books are also turned over to the department of health for decision regarding disposal. Books exposed to measles, etc., are boxed at the libraries and at intervals such collections are sent to the health department for treatment or cremation at its discretion.

Moving Picture Halls.—In moving picture halls the special attending evils are overcrowding and insufficient ventilation. Such rooms are necessarily kept dark and this tends to cut down the window space; suitable shades are expensive, and they are difficult to keep well adjusted (to avoid flapping and the entrance of light); and the tendency is to keep the windows shut or to resort to insufficient ventilating shafts, etc. People are crowded too close to each other; under such conditions organisms discharged from the nose and mouth are most readily transferred. The large number of children in the audiences increases the transfer of many com-

municable diseases, for children are especially susceptible to certain diseases (Fig. 53).

In churches, granges, ladies' aid societies, etc., the social side has its peculiar dangers. Food is too often contributed from homes below the sanitary standards. The general lack of running water and the short supply of any water, especially hot water, in such buildings, do not generally allow the proper washing of dishes and spoons, nor of the hands of those who serve or otherwise handle the food.

RESTAURANTS, ICE CREAM PARLORS, SODA WATER STANDS, BAKERIES, ETC.

Protection of Food.—Food displayed in windows or on counters should be under glass to protect it from dust, flies, and from patrons who are not always considerate about handling rolls, candies, etc. Very often while making selections or payment, packages, books, and even muffs are deposited temporarily upon such trays of food, or dirty fur cuffs and neck pieces are allowed to brush over them. High-grade stores now insist that clerks handle candies with scoops or tongs. Such rulings are a great help, but they do not entirely protect one against the empty-headed; recently in one of the shops of a candy firm known on both sides of the Atlantic a patron watched an idle clerk toying with her candy tongs, using them against her teeth to open and shut her lips. Even so, her tongs were probably safer than *her* fingers would be, but she had failed entirely to grasp the reason for the ruling regarding candy handling. Unbroken wrappers should be extended to include oiled paper covers or boxes for bread, cakes, and pies.

Care of Utensils.—Important also is the care of glasses, dishes, etc., used in serving soda, ice cream, and even hot drinks, for they are rarely hot enough to disinfect the glasses or cups. All such utensils should be washed in *hot soapy* water and also rinsed in clean, *hot* water and preferably *drained* dry.[1] Only fresh towels should be used for drying dishes or glasses; napkins used by patrons

[1] The automatic arrangements for washing glasses should provide a slanting rack for draining after washing, especially if they are re-used before they are dry. Some of the devices now used do not come up to the standards described above.

should never be used. Cream dishes are difficult to wash, and special care is necessary to remove the greasy film. Paper dishes, spoons and cups should be more generally used in eating places. The dishes can be set in silver holders, etc., if appearance is important. In such matters cleanliness comes first with all sensible people.

Other Regulations.—Such places should provide adequate toilet facilities for the workers with running hot water, soap, and paper towels for hand washing. All employees serving food or handling uncooked foods should be shown to be free from tuberculosis or other communicable diseases. Typhoid, dysentery, diphtheria, and meningitis carriers should be eliminated by tests made at least once a year..

HOTELS

All that was said in the preceding section concerning restaurants applies to hotels. Most of the subject-matter in the chapter on the home is also applicable here. Large hotels make advertising use of their finely equipped kitchens, and that usually insures a certain degree of cleanliness.

Personal Habits of Attendants.—Objectionable personal habits may destroy the values aimed at in sanitary regulations. For example, in many of the hotels the waiters wear white wash gloves at banquets, etc., especially in the summer time when perspiration is to be considered; it is little pleasure to watch such waiters rub their mouths or noses with the gloved hand before handling your spoon or plate.

Towels and Napkins.—Towels and napkins laundered outside by supply houses should be sent home wrapped in fresh paper. Tied piles of folded napkins with unprotected edges are often carried by drivers in soiled hands or piled on the floor of carts not washed since soiled ones were collected. The dangers may not be great, but the situation is not exactly pleasant to contemplate.

Finger Bowls.—Finger bowls should have a fresh paper lining, or be sent to the kitchens to be washed just as thoroughly as the other dishes are washed.

Drinking Water.—Hotels might well be required to post placards and print on the bills-of-fare the source of the drinking water

and the treatment to which it has been subjected by the hotel or the community.

Bedrooms and Bathrooms.—Room occupants should wash bathing and toilet appliances thoroughly before using them. Chambermaids in even the best hotels too often dry the basins, tooth mugs, etc., with towels carried from room to room; slightly soiled towels collected as they go from room to room are sometimes used, too.

Bedding cannot be entirely replaced for each patron. But clean sheets can and should be supplied. To save a trip to the distant linen room, or rather than wait for the next supply of laundry, a chambermaid will often use a once-used sheet as the under sheet. In such cases *both* sheets should be replaced by fresh ones. Sheets should be long enough to protect the occupant from contact with used or soiled blankets or other bed coverings. For some time even intelligent people took as a joke the nine-foot sheet rule demanded by one of our States, failing entirely to see its hygienic importance.

DENTAL OFFICES, BARBER AND MANICURE SHOPS

Dental Offices.—Dentists' tools should be steam-sterilized, boiled or chemically disinfected after each patron. This applies to the water syringe and to the water glasses, which are sometimes left out when the other appliances are treated.

Hairdressers and Barbers.—Hairdressers and barbers should boil or steam-sterilize combs, cups, razors, brushes, etc., after each patron. Towels are often dried without washing and then used again. Drying on radiators, etc., does not necessarily destroy bacteria. Neck boils or carbuncles and other skin infections are often traced to barber shops; if organisms chance to get on any broken surface, such as razor cuts, or the places chafed by stiff collars, infection is much more likely to occur. Individual appliances are sometimes left or kept at barber shops, manicure shops, etc., but too many people have the habit of dropping into any convenient place.

Manicure Shops.—The danger in manicure shops is mainly limited to infection through breaks in the skin; cutting the cuticle too deep may give similar opportunity for entrance. Little infection is probably transferred through manicuring.

In all the above situations there is the æsthetic side to be considered, which should make us demand absolute cleanliness in the appliances used. Assistants suffering from such diseases as acne (G), gonorrhœa (G), and syphilis (G) should not be employed in any of these places.

WAITING ROOMS IN STORES, RAILROAD STATIONS, ETC.

Drinking Arrangements.—Individual cups should be provided free or for sale in automatic holders. Drinking fountains should be absolutely safe, if used at all (Fig. 79).

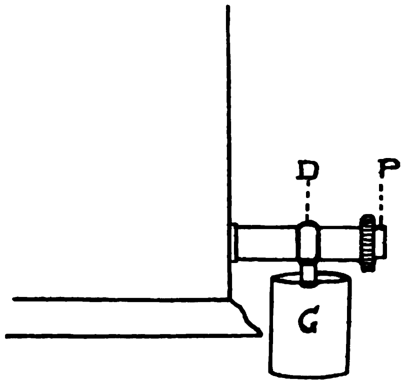

FIG. 87.—In this faucet notice that there is plenty of room for the glass, so that drip from the plunger, P, need not run into the glass. Make sure the faucets you use are safe.

The faucets of water coolers are often short, tiny plugs or plungers which allow the water to drip over the plunger soiled by contact with many fingers, or over the fingers themselves into the glass of water (Fig. 87). Faucets are made short to avoid breakage; longer ones, which bring the fingers and plunger drip *outside* the drinking glass, should be substituted.

Toilet Arrangements.—Toilet rooms should be light and roomy; good illumination should be provided at night. Nails should be provided for hanging wraps, also a low shelf for heavy or bulky articles and a higher, smaller one for small articles (purse, etc.). Each patron can secure a safe surface for such personal articles by using a fresh paper towel.

The toilet seats should be U-shaped; most water flushing ar-

rangements can be worked by the foot. Knobs can be turned by the gloved hand or with protecting bits of paper toweling. Arrangements for washing the hands are necessary, and should always be provided.

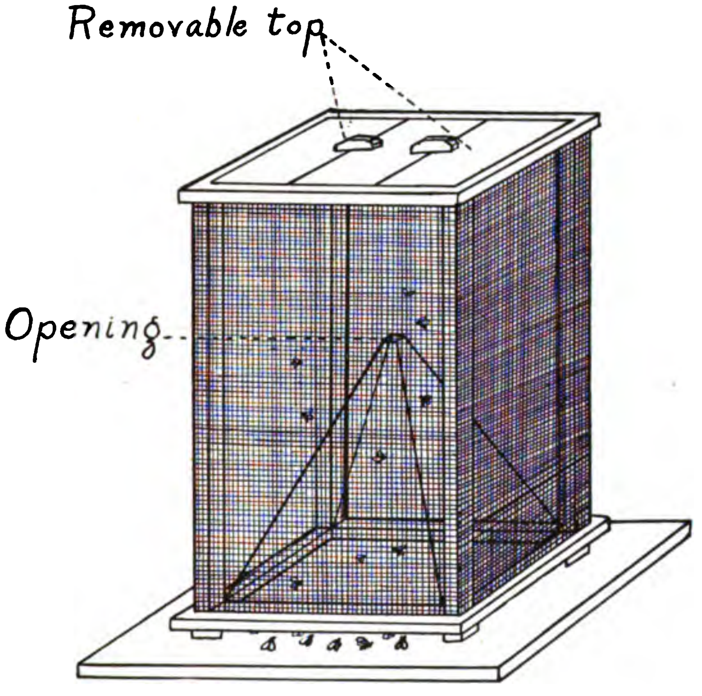

FIG. 88.—A fly trap. Sweetened bread is placed on the board base underneath the trap; after feeding, the flies fly upward through the opening and are held in the top of the cage.

STORES AND MARKETS

Care of Food.—Food used raw or not done up in packages should be kept at least two feet above the floor line. Dogs and cats should be kept out of such places. It is not uncommon to see the "store cat" walking over the food, or sunning herself in the window. Rats and mice can be effectively cleaned out by traps; and traps do not *add* to the sanitary problems as cats do.

Flies.—Flies should be kept out. It is difficult to control flies. Sticky fly-strips from the ceiling, wire fly traps (Fig. 88), and

formalin-poisoned bread (see Appendix) are valuable aids, if rightly managed. The prompt removal of refuse from the back room or the back step, and keeping the stable free from manure are both important aids in decreasing the number of flies. Flies breed in horse manure; 12,000 larvæ (G) were once counted in one pound of horse manure. The stable should be as far from the store as possible. Prompt removal of all refuse, including garbage, is necessary.

Scoring Shops.—Wood suggests scoring stores and markets for such points as freedom from flies and refuse. This might be applicable in communities where there are a number of stores. In smaller communities something ought to be done in stimulating a friendly competition, *e.g.*, having the local paper announce in May that patrons are invited to compare the number of flies found in each store on a definite date, *e.g.*, the first of June—or Fourth of July. Such measures develop a certain sensitiveness to the fly question on the part of patrons as well as shopkeepers.

Other Essentials.—Toilets and opportunities for washing the hands are essential. Only fresh water should be used to freshen vegetables; and the pails, tubs, etc., should be cleaned and dried between periods of use.

LAUNDRIES

Dangers.—The dangers from laundries come from two conditions: (1) The washing and ironing processes may be so imperfectly performed that the organisms originally present are not destroyed; in such cases they may be transferred to other clothing washed with the infected clothing. (2) Finished laundry may be infected by its treatment after washing and ironing have been completed.

Effect of Laundry Processes on Bacteria.—The methods of washing and ironing vary so greatly that it is difficult to discuss this topic briefly. Washing with hot, soapy water, boiling in hot water, and rinsing in one or more waters are fairly uniform parts of the washing process in most homes. To these are added drying in fresh air and sunlight, and ironing. Under such home conditions there is practically no danger from infected linen. Drying at the high temperatures used in the drying rooms of the large laun-

dries destroys harmful bacteria. Ironing by hand, by machine, and by mangle usually means an effective degree of heat. This was tested by clothes which were soaked with known bacteria. After ironing, these bacteria could not be recovered, if the clothes had been ironed to give the customary degree of smoothness. There is a little danger that seams and thick edges may not be so completely affected by ironing; if clothes are run too rapidly through the mangle, complete safety is not assured. If the preliminary processes of washing and drying are properly done, ironing usually completes satisfactorily the safeguards to health.

Private or Home Laundries.—Home washing and ironing processes are usually efficient as indicated above. Private laundresses may do the work in the same thorough way. Often they are much less careful. Too often the clothes are dried in the overcrowded living room; they may not be kept apart from other soiled clothes—even after ironing. Such intimate association with the family makes possible transfer of tuberculosis and other communicable diseases.

Steam Laundries.—Many of the large steam laundries wash the clothes after they are packed into large nets (90 per cent. in the recent New York City investigation). These tightly-packed nets are not always penetrated sufficiently by the hot water and the soap. In some tests over half of the sugar and salt left in the interior of such nets was recovered unmelted. Soiled clothes in such nets may, therefore, transfer organisms to other clothing. "Wet wash clothes" which are returned to the various homes may contain dangerous organisms. Most so-called "hand laundries" give their washing over to steam laundries and dry the returned wet-washed clothes in little crowded rooms which are also usually occupied for living purposes. They have, therefore, no advantages over the ordinary low-grade private laundress. Many "hand laundries" are merely receiving stations for steam laundries, all the laundry processes being done at the central steam laundries. Schroeder and Southerland recommend that all clothes washed by steam laundries be dried on the same premises to insure the complete destruction of objectionable bacteria. In the self-contained laundries where this is done the high temperature used in drying completes the process of bacterial destruction. Colored and woolen clothes are not so satisfactorily treated as other clothes.

Chinese Laundries.—On the whole, Chinese laundries compare very favorably with other commercial laundries. They are apparently more careful to keep clean clothes from contact with soiled ones (sorting ironed clothes on separate places, or clean ironing boards). Fewer of them lived in such close contact with the clothes as in the small "hand laundries." In these the sprinkling of clothes for ironing was more often done by a blow-can, which is worked by the mouth to throw a spray of water over the clothes. The florist's bulb, the bottle sprinkler, or the plain whisk broom are preferable; as several workers often use the same mouth spray, there is danger that they may transfer mouth organisms to the clothes, also. Such sprays operated by mouth are prohibited in a few of our cities.

General Criticisms.—In general, more care should be taken to separate clean and soiled linen in the receiving, sorting, and packing rooms; clean and soiled clothes should not be packed together into the same delivery wagon, and clean wagons should be used to deliver washed clothes. Wet-washing in nets does not usually allow sufficient action of the hot water and soap. Disinfecting chemicals strong enough to do what ordinary laundry processes ought to do are either too expensive or injurious to clothes. Wet washing is "a possible menace to the public health." Infected helpers in the final sorting room may be eliminated by requiring examinations for such diseases as tuberculosis at least once a year. Although net washing is not a satisfactory process, clothes dried *in the steam laundries* in highly heated rooms, and ironed by hand, machine, or properly heated mangles, may be quite free from undesirable organisms, if proper attention is paid to the final handling and the delivery (wagons, etc.).

Community Laundries.—Laundries should be definitely under municipal control, and compelled to conform to certain standards, *e.g.,* temperature of drying rooms, final handling only by people free from communicable diseases, and separation of living and laundry operations. In San Francisco, for example, an application for establishing a laundry can be granted only after a public hearing. A few places conduct municipal or community laundries; some of these unfortunately warrant the criticisms given above.

PROBLEMS

1. One city has a municipal wash house where housekeepers in the neighborhood may bring their family washing. What arguments for such an arrangement?

What rules should govern the management?

2. Make a set of sanitary rules for the janitorial staff of public buildings.

3. One city has a janitor school for its custodians of buildings. What would you have taught in such a school?

4. Where in our school system can persons be taught the health essentials which should be understood by grocery clerks, waitresses and other food handlers? What rules of personal action can you suggest as a basis of such instruction?

5. What problems of public conveyances (street cars, sleeping cars) are not answered by the Chapters XIII, XVI and VI?

6. Beds or bedding should be aired for at least one hour each day. How long are they aired in your boarding house? Are they sunned as well?

7. Table napkins are too often piled into a common drawer. This is especially undesirable where strangers eat together, as in boarding houses. If paper napkins are not substituted, a protective covering should be used, as in tuberculosis sanatoriums. Can you design a simple but attractive case or envelope? It need not be closed on all sides as envelopes are, if the cover projects beyond the napkin; it should, of course, be washable or easily laundered.

8. Which is the best store (market, ice cream saloon, or laundry) in your locality from the point of care of utensils (*e. g.*, care of chopping block, spoons, finger bowls) and personal habits of the employees?

9. Make a set of rules to post for the guidance of restaurant employees, which would tend to prevent disease transfer to patrons.

10. Make similar simple rules for a mother to use in establishing proper habits in her child. Give concrete illustrations that would make the dangers realistic to a child of 5; to a child of 10.

11. In how many of the situations or conditions discussed in this chapter should non-spitting regulations be enforced?

See Reference List at end of Appendix.

CHAPTER XVII

INFANT WELFARE

INFANT mortality is not a complete index of infant welfare conditions, because there is more to the question than the number of the dead and the number of the living. Mere survival means little; the important thing to the individual and to the community is the physical and mental equipment with which the survivor faces the coming years.

Nevertheless, mortality figures are a very convenient way of calling attention to the whole problem of infant welfare. High death rates always mean conditions which should be remedied in part, at least. Even discounting somewhat for the fact that correct birth figures are difficult [1] to obtain, the wide range in infant mortality rates given in the next paragraph indicates that the conditions are very unequal, even in the parts of the world where health is a matter of general concern.

Mortality Figures.—Figures compiled seven years ago credit Australia with but 75 deaths per thousand births (see Chapter XXIV for method of estimating such statistics), while Prussia has 157 and Hungary 195 deaths per thousand births. Russia has a very high infant mortality rate—over 250, and in some localities as high as 370, as estimated by the recent Red Cross commission to Russia. In the United States the average is lower, 124 per thousand births in the 1911 census report, though some localities run up to 200; in New York State and in New York City also the rates are below 100; the 1917 records for New York City give the infant mortality rate at but 89 per thousand births. The last report for England and Wales gives for 1916 the lowest rate ever recorded for those countries, 94 per thousand births.

It is only during the last few years that there has been a decided drop in the infant mortality rates. Some attribute this to the de-

[1] Due to the incomplete registration of births (explained mainly by ignorance, carelessness and illegitimacy) and to the fact that the age is often incorrectly given, *e.g.*, ages under one year being given as one year.

creased birth [2] rate, and while this doubtless had its effect, most of it must be due to the bettering of general hygienic conditions (*e.g.*, pure water, which affects dysentery and diarrhœa) and still more to efforts designed to protect the babies themselves.

The need in the United States is shown by the following statements made by reputable authorities: One in every eight babies dies the first year; in the registration area (G) in any year one-fifth of the deaths of all ages are those of children less than one year old, and one-quarter of the total deaths are those of children less than two years old.

Causes of Infant Mortality.—The causes of high infant mortality rates are numerous indeed. They may be best discussed under (1) inheritance, (2) conditions at and before birth, (3) general environmental conditions following birth: *e.g.*, fresh air, food, care, and cleanliness, and (4) specific infant diseases (not covered by the preceding topics).

Inheritance.—(1) Technically, actual diseases are not inherited; real inheritance is rare even in syphilis (see next paragraph). What the child does inherit is a tendency to this or that disease (*e.g.*, tuberculosis) through malformed organs (*e.g.*, contracted chest) or general low vitality and resistance; family histories of certain diseases may be due to such inheritance (*e.g.*, cancer or tuberculosis). In many cases, however, family diseases may be due to the many repeated opportunities for infection (*e.g.*, tuberculosis).

(2) At birth children may be found to be infected with the venereal diseases, less often with tuberculosis. While such parents infected with syphilis do not always have infected children, the chances are that the children will not escape; figures support this, if we include the large number of still births, which are in so great part traceable to this disease. Definite malformations (bone, visceral organs), general physical deficiency, as well as mental weakness ranging from slight subnormality to actual idiocy are common manifestations of such pre-birth conditions. Blindness is often due to gonorrhœa, acquired usually at the time of birth, even when

[2] At first reading this seems impossible, because infant deaths are estimated in proportion to the births, but figures show that increases in the birth rate increase the relative number of infant deaths, and *vice versa*.

born of an infected mother, or by organisms from the hands of the doctor or nurse.[3]

Conditions at and Before Birth.—(3) Pre-natal conditions relating to the physical health of the mother (overwork, malnutrition) have an important effect upon the health of the child. Ignorance causes many a physical handicap; economic conditions are responsible for still more, however (Fig. 91).

In foreign countries where a larger number of married women are employed in the industries, we find more definite laws tending to secure better conditions for the periods preceding or following birth. In France, teachers and women in the government employ are given two months leave with treatment and full pay. In Italy, all factories employing fifty or more women must provide a room where they may feed their infants, and extra time (one-half to one hour) must be allowed for caring for the children. In this country but four States (1917) have passed industrial laws covering this same field. Massachusetts and Vermont require cessation of labor for two weeks before and four weeks after birth; Connecticut, for four weeks before and four weeks after birth; and New York, for four weeks after birth. The lifting of heavy weights by women is prevented (pulleys, etc.) in but one State, Massachusetts, and there but for weights of 75 pounds or more. When one recalls, for example, the revelations of recent investigations of the conditions of women working in twine and cordage mills employing over 17,000 women and children, and remembers that in some cases the spray and drip from the wet fibres often wet the clothes to above the waist line, and that water may collect in such pools that the workers are forced to go barefooted, we can see that our laws are most insufficient. We cannot excuse our inadequate legislation by showing that we employ fewer women than men in industry.

Ignorance on the part of parents is responsible for many unfavorable pre-birth conditions. Nationalities in the same crowded districts will vary astonishingly in the infant mortality rates. These mortality differences are, of course, partly due to after-birth conditions, such as feeding and lack of cleanliness mentioned in the next section of this chapter. They very often vary greatly with racial lines; in Chicago the highest death rates were in the Polish

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[3] Other bacteria, ordinarily quite harmless, may also multiply in the delicate eye membranes, causing blindness.

sections rather than the less crowded Italian districts. Wood considers the Poles and Slavs responsible for the high infant death rate of Chicago. Another factor is the lack of suitable healthful exercise for the mother. The habit of staying indoors and the more or less enforced sedentary life are both important considerations when one reflects that the mother must supply sufficient oxygen for two beings. Constipation and digestive disturbances are other problems receiving too little attention at this time. There is great need of better pre-birth advice than the baby-clinics and baby-welfare stations can give. Every town and every county should have a sufficient number of free clinics hours (some at night) for advising prospective mothers who cannot afford medical aid.

Midwives.—Another important factor in birth fatalities is the midwife. Over 40 per cent. of all births are attended only by midwives; this usually means no pre-natal medical advice at all. When one recalls the absolute ignorance of most midwives and the low type of clients which make up the majority of their patients, the opportunity for disease transfer is appalling. Almost as great is the evil resulting from their ignorant superstitions regarding care, feeding, etc. Some southern cities have had appalling death rates traceable to the negro midwives. Until a community can provide free clinical advice to prospective mothers, and hospital beds or nurses in the homes for all the poor mothers, the midwife is the only recourse left the poor. Meantime, it is at least in the power of every community to enforce the registration, education (by lectures and demonstrations), and licensing of all who are to act as midwives.

Environmental Factors.—The conditions in early life most important are food, care, cleanliness, rest, temperature, and avoidance of disease transfer.

Food.—The natural food is milk, of course. Mother's milk is undeniably better than cow's milk. Eighty per cent. of all deaths in the first year are among the bottle-fed babies, though the bottle-fed represent but 20 per cent. of the babies. Diarrhœa is nearly three times as common in cow-fed as in breast-fed babies. This indicates that breast feeding should be used whenever possible. The money spent for cow's milk could be more profitably spent for better food for the mother. If cow's milk must be used, it should be pasteurized unless "certified" cow's milk (see p. 86) is used. Mixed

cow's milk is more uniform than the milk of a single cow, and is now preferred to "one-cow's milk." Any lack in vitamines (G) due to pasteurization can be replaced by giving the baby daily one to three teaspoons of orange juice, cereal water or potato water. Simple directions for the home pasteurization of milk are given in the Appendix. (See also Chapter IV on Milk.) Cow's milk is poorer in sugar, about the same in fat, and richer in protein and minerals than human milk. When modified to secure the preferred protein proportion, by adding equal amounts of boiled water or boiled barley water, the other substances fall below the proportion in mother's milk. It is, therefore, suggested that the top milk be poured off for the baby's use. This, containing more of the fat, is, when modified, nearer the desired proportions. Sugar can easily be added, cane sugar or preferably milk sugar. The exact modifications necessary vary with the individual and the age; the advice of doctors or nurses should be secured when possible. Some of the large dairies prepare a modified milk according to the directions of local physicians.

Pasteurized or certified milk should be kept cool until used. Bottles, nipples, as well as the milk, should be kept from flies; they should be cleaned promptly, soaked in soda water,[4] cleaned, dried,[5] and if possible sunned after use.

Goat's Milk.—Goats are remarkably free from tuberculosis (no trace in over 13,000 goats slaughtered); and goat's milk is, therefore, strongly recommended by many people. The milk is fully as digestible as cow's milk, and children not doing well on other milk foods have sometimes been greatly benefited by a change to goat's milk. Many people could keep a goat who lack space for a cow; the goat is also a cleaner animal than the cow (fæcal matter rarely adhering to the coat, etc.). There is, however, one danger in goat's milk. Goats in the Mediterranean countries frequently transfer Malta fever through the milk, and the wholesale use of goats in this country might be dangerous, although the disease is not common in our goats at present.

Pasteurized Milk.—The early prejudice against pasteurized milk is almost dispelled. If any mothers or nurses still need to be

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[4] About one teaspoonful to a quart of water.

[5] Some prefer to keep the nipples (after thorough washing) in saturated solution of boric acid.

convinced, see the table on page 84. There are many other figures to support the value of pasteurized milk. In one experiment one hundred and ten babies averaged a daily gain of .4312 ounces on raw milk, but gained .4607 ounces when transferred to pasteurized milk. This may seem slight, but it means over half a pound a year.

Babies are often overfed. Such a baby cries because he has indigestion from too much food, not because " he is hungry." One and a half ounces of milk to each pound weight is a common standard. In sickness the amount of milk should be reduced. Cereal water is a good temporary substitute for sick babies; continued indisposition demands medical advice, for babies " die very easily."

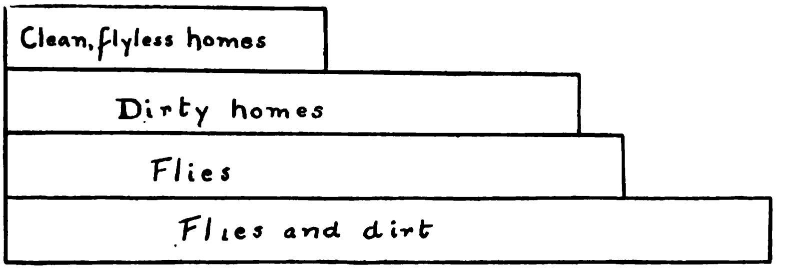

FIG. 89.—Proportion of diarrhœa cases developing in homes of babies classed as above. (Based on figures in Health News, July, 1915.)

Water is a necessary part of every baby's diet. The addition of foods other than milk should be adapted to the age and digestive peculiarities of the individual child. Most parents begin outside feeding too soon. Lately, attention has been called to the danger of giving a child too much of a new food the first time. There is great danger with some foods (such as eggs and strawberries) that a child may be thus made a "food-sensitive" (G, also p. 210).

Cleanliness of food has already been mentioned, but general cleanliness needs emphasis also. Bathing has soothing and stimulating effects of inestimable value. The prompt washing of diapers soiled with excreta apparently improved the health markedly in one experiment in tenement districts. Intestinal diseases are often flyborne; avoidance of conditions that attract flies and fly-screening are important aids (Fig. 89).

Temperature.—Hot weather has a marked effect upon the health of babies; death and sickness rates rise with or just after intensely

hot periods (Fig. 90). As Winslow has pointed out, most babies cannot stand the double handicap of poor milk and hot weather. The three-month summer death rate is often equal to that of the remaining nine months. Clothing should be modified with temperature; many layers of clothing and rubberized diapers should be avoided in very hot weather. Cool roof gardens, recreation piers (though too crowded and noisy), or dry basement rooms should be available part of the day for every child condemned to summer in warm climates. Hospitals are slowly adding cooled rooms where such respite from intense summer heat may be secured.

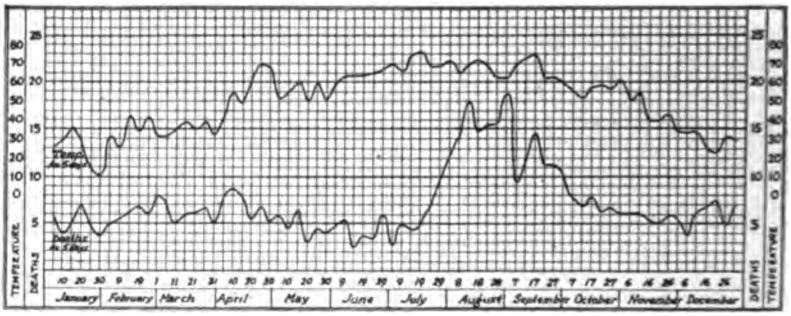

Fig. 90.—The relation between temperature and deaths from diarrhœa. Five-day averages for children under two years of age in Chicago, 1915.

Care Important.—Care, as a life factor, is most important. How important has been emphasized by almost all writers on infant welfare, by citing the low death rates of the babies in such emergencies as the siege of Paris and prolonged strikes, such as those of the Lancashire cotton mills, where the death rate fell to 40 per cent. despite the almost famine conditions that existed.

Rosenau states that infant mortality increases in proportion to the working time mothers spend outside the home, even when the increased income is used for increased comforts in the home (Figs. 91 and 92). The mortality rates for factory centres support this. Figures of twenty to thirty years ago give an average rate of 174.9 per thousand births for cities; but the rates for factory towns at that time are illustrated by the following: 239 for Fall River, 222 for Lowell, and 213 for Lawrence. In 1914, when the mortality rate

for New York City was but 94 per thousand births, other cities in that State had disgracefully high rates: Watervliet, 160; Rensselaer, 178; Cohoes, 205; and Lackawanna, 352.

Other Factors.—Minor factors, such as illegitimacy, the age of the parents, and the possible effects of infant life insurance are

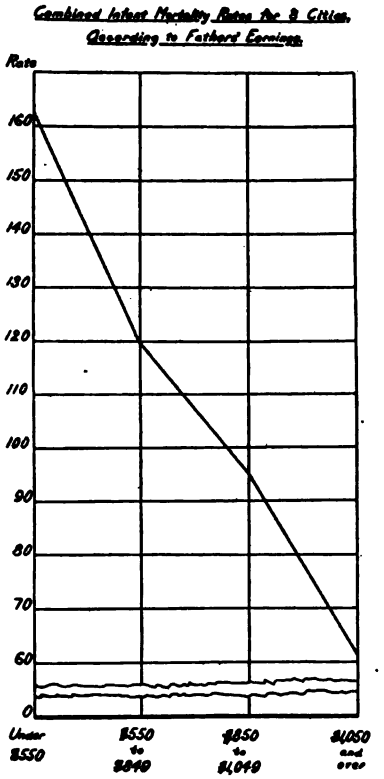

FIG. 91.—What argument here for minimum wage? For price fixing of rent, food, coal, etc.?

all economic phases, which deserve serious attention, but which need only to be stated to be realized.

Special Diseases.—Diarrhœa and similar intestinal disturbances cause one-quarter to one-third of all infant diseases. These are in great part due to the food conditions; indigestible foods are predisposing factors, though the diseases are mainly due to organ-

isms conveyed in the food. The direct relation between pasteurized and raw milk and diarrhœa is shown by the table on page 84.

Respiratory diseases play too large a part in infant mortality. They, with diarrhœa, cause about 50 per cent. of all infant deaths. Contact with adults suffering with any respiratory infection should be avoided.

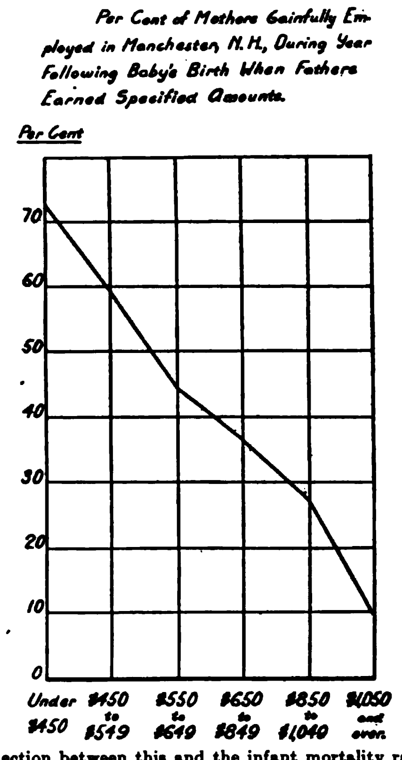

FIG. 92.—What connection between this and the infant mortality rates of manufacturing cities? (See Fig. 91.)

Helpful Suggestions.—What to do has been implied throughout in the preceding discussion of the causes of infant mortality. How to do it may not be quite so clear.

Milk Stations.—Almost a generation ago the first baby milk stations were started in this country for the purpose of providing

good milk for the babies. Doctor Josephine Baker says the problem of infant welfare is 20 per cent. milk and 80 per cent. education of the mothers, and the history of the milk stations proves this. The first milk stations in the United States were the Straus milk stations in New York City, 1889, providing good milk free or at cost price. From providing good milk to showing the mothers how to pasteurize the milk was a natural step. Now many of the stations have not only nurses but physicians in attendance several hours a day for consultation, not only regarding the baby's condition, but often as advisers to the mothers during the pre-birth period. In many stations a welfare pamphlet is sent to the mother as soon as the birth is registered. One of the visiting nurses soon follows this up, visiting the child about every ten days; such nurses in New York City average 150 babies each.

Baby Clinics.—Baby clinics are even more necessary in the country than in the city, and, as recommended for other conditions, a travelling baby clinic is really quite feasible, once the people know that they want it. They should, of course, be combined with an advisory clinic for expectant mothers.

Day Nurseries.—Day nurseries, too, need no commendation. If mothers must work, a safe, clean place must be provided for the children. In the more progressive cities a system of mother's pensions make day nurseries less necessary. Day nurseries should be open to inspection by the board of health, and conform to the laws of such boards; they should provide only healthy attendants, and segregate infected children or suspects, if such are received.

Other Aids.—Rest farms or some vacation scheme for mothers and babies is also desirable. When we, as a nation, realize all the forms the "ounce of prevention" can take, it will not be necessary to enumerate to an intelligent community the advantages to the community as well as to the individual of such infant welfare work. Pending the time when adequate attention can be given by mothers and nurses, the Little Mothers societies are well worth while; in New York City over 17,000 children help in this way. But the problem is not a child's problem, and should be dignified by the serious attention of the most intelligent and influential members of the community. The State of Iowa has recently appropriated $25,000 annually for research in child welfare. (See p. 373.)

The Pre-school Period.—Attention is now being directed to

the pre-school period, under five or six, which has not shared all the benefits gained by infants (under one year).

Sleep.—Most of the conditions discussed before apply here. Still more might we emphasize the need of rest or sleep—not only the daily nap, which parents find it easier to "let go," but a long night sleep. Our slum streets are full of tiny children long after nightfall; it is rare, even among the more prosperous and more intelligent, for a child of five to have the eleven to thirteen hours of sleep physiologists recommend (Fig. 86). If each one of us could spend a continuous period of twenty-four hours in a tenement district where the din of trolleys, elevateds, and trucks is only equalled by the noise of dumb waiters, garbage cans and phonographs and the constant turmoil of a constantly changing house personnel of day and night workers, and the cries and shouts of next-door neighbors whose windows open directly into yours, one would understand why sleep is impossible except from sheer exhaustion, and recognize that we haven't done our duty to children until we have made for them "a quiet place." Kindergartens and such refuges help, but until we have no slums, American ingenuity should devise some scheme for quiet rest or sleep not possible now day or night in the homes of many thousands of children. Why not night nurseries as well as day nurseries? It would help many a nervous, delicate child who does not need day nursery care. Such buildings could easily be used in "two shifts."

Food.—While children of three or more years of age are less affected by a somewhat poorer grade of milk, food is still a most important factor. Fruits and vegetables should now be an important part of the diet. (See Chapter III, especially vitamines.) Rickets and lack of growth are directly food problems.

Defects.—The defects that show up so appallingly in school children should be detected here, and remedied in time to prevent any handicap after entering school.

Contagious Diseases.—Contagious diseases should be avoided—even the mildest (see Fig. 53). No one can predict the full extent of the after-effects of any disease. People who object to scientific vaccination against smallpox will repeatedly expose their children to diseases spread by nasal discharges, filthy flies, or fæcal wastes without a qualm, Whooping cough causes more deaths than scarlet fever, and in some years more than any other communicable

disease. The need for greater protection of little children from communicable diseases is indicated by the high death rate of children under five; 96 per cent. of the total deaths occur in this group.

PROBLEMS

1. What private organizations interested in infant welfare are helping in your community?
2. Does your city, county or state do anything to promote infant welfare?
3. Make a curve showing the infant death rate per 1000 births for your community for the last ten years.
4. Make a similar curve giving a comparison of summer and winter death rates for infants.
5. Spot the infant deaths for two continuous years on a map of your community. What factors—overcrowding, nationality, poverty, etc.—seem most important?
6. Show why the term "slaughter of the innocents" is often rightly used in relation to certain communities.
7. Debate the following: Fifty per cent. of all infant deaths are preventable.
8. Make a list of ten "Don'ts for the Baby."
9. Plan an exhibit on Child Welfare, describing what charts, posters and other exhibits you would have.
10. How can you help the Children's Bureau in its campaign to save 100,000 babies in 1918? Write that Bureau in Washington for information. What materials can be secured from the sources mentioned on p. 373?

See Reference List at end of Appendix.

CHAPTER XVIII

MIDDLE AGE

Life Expectation Averages.—Infant welfare work in the last forty years has so improved the conditions of little children that the average expectation of life for children under five has been raised from forty-one to fifty-one years, an increase of ten years. In 1879, as indicated by the following table, children who had safely reached the age of ten would live, on an average, 43.8 years longer. In 1909, the average expectation would be 46.9, or three years more.

As shown in the table given below, this increase becomes negligible at middle age; and the expectation of life averages less after forty years is reached. The net gain is fourteen years, however, and this apparent drop may only mean that those who would have died at five or ten fall out at thirty or forty. Of course, we really can't decrease the death *rate;* every one born must die some time, and it is a question how long death can be deferred—or how much we can decrease the death rate *for given ages.* Many feel that if the needs of late youth and middle age were properly met, this drop after thirty would not occur—that a gain would be possible even here.

Age Changes.—There are at middle age certain natural changes in the body that predispose to disease. The blood-vessels are less

TABLE FOR NEW YORK CITY SHOWING PROBABLE YEARS OF LIFE FOR VARIOUS AGES FOR TWO PERIODS A GENERATION (THIRTY YEARS) APART (GUILFOY)

Age	Average expectation in 1879–1881	Average expectation in 1909–1911	Gain	Loss
Under 5.....	41.3	51.9	10.6	....
5.....	46.3	51.1	4.8	....
10.....	43.8	46.9	3.1	....
20.....	35.8	38.3	2.5	....
30.....	29.6	30.5	.9	....
40.....	23.9	23.4	....	.5
50.....	18.3	16.8	....	1.5
60.....	13.0	11.3	....	1.7
70.....	8.9	7.2	....	1.7
80.....	6.4	4.3	....	2.1
			Total gain 21.9	Total loss..7.5

able to make the usual adjustments. This is partly due to the increase in fatty connective tissue characteristic of age, which tends to compress such important organs as the heart and other blood-vessels; this condition not only affects the distribution of the blood, but may also affect directly such soft glands as the kidneys. The walls of the blood-vessels are themselves less elastic with increasing age; even where actual rupture of the vessels does not occur (apoplexy, hemorrhage) the distribution of the blood supply is materially affected, and the body lacks its former power of instant and complete adjustment of the blood supply.

Obesity.—Obesity has many disadvantages; it means a larger bulk to nourish and move around, and entails more work for the muscles and the organs of digestion and excretion. H. D. Chapin says that the prospect of a long and vigorous life diminishes as the waist line bulges beyond the chest line. Insurance figures show, for given age and height, increasing death rates with the increase in weight; they also show that a decrease in the death rate goes with a moderate decrease below the average weight for a given age and height. The tables following give the *average* weights for men and women (pp. 297, 298). Weights slightly below these are shown by life insurance records on page 298 to be more favorable to vitality and longevity. It would probably be well to keep one's weight ten to fifteen pounds below the averages given here. In other words, underweights are better risks than even average weights.

SYMONDS'S TABLE OF HEIGHT AND WEIGHT FOR MEN AT DIFFERENT AGES
Based on 74,162 Accepted Applicants for Life Insurance
(*Medical Record*)

Ages	15–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69
5 ft. 3 in.	127	131	134	136	139	141	141	141	140	140
4 in.	131	135	138	140	143	144	145	145	144	143
5 in.	134	138	141	143	146	147	149	149	148	147
6 in.	138	142	145	147	150	151	153	153	153	151
7 in.	142	147	150	152	155	156	158	158	158	156
8 in.	146	151	154	157	160	161	163	163	163	162
9 in.	150	155	159	162	165	166	167	168	168	168
10 in.	154	159	164	167	170	171	172	173	174	174
11 in.	159	164	169	173	175	177	177	178	180	180
6 ft. 0 in.	165	170	175	179	180	183	182	183	185	185
1 in.	170	177	181	185	186	189	188	189	189	189
2 in.	176	184	188	192	194	196	194	194	192	192

SYMONDS'S TABLE OF HEIGHT AND WEIGHT FOR WOMEN AT DIFFERENT AGES
Based on 58,855 Accepted Applicants for Life Insurance
(*McClure's Magazine*)

Ages	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
4 ft. 11 in.	111	113	115	117	119	122	125	128	128	126
5 ft. 0 in.	113	114	117	119	122	125	128	130	131	129
1 in.	115	116	118	121	124	128	131	133	134	132
2 in.	117	118	120	123	127	132	134	137	137	136
3 in.	120	122	124	127	131	135	138	141	141	140
4 in.	123	125	127	130	134	138	142	145	145	144
5 in.	125	128	131	135	139	143	147	149	149	148
6 in.	128	132	135	137	143	146	151	153	153	152
7 in.	132	135	139	143	147	150	154	157	156	155
8 in.	136	140	143	147	151	155	158	161	161	160
9 in.	140	144	147	151	155	159	163	166	166	165
10 in.	144	147	151	155	159	163	167	170	170	169

THE RELATION OF OVERWEIGHT TO DEATH RATES

Overweight	Death rate increase
5 pounds	8 per cent. higher
15 pounds	18 per cent. higher
30 pounds	32 per cent. higher
40 pounds	49 per cent. higher
50 pounds	60 per cent. higher
60 pounds	70 per cent. higher
70 pounds	85 per cent. higher

THE RELATION OF UNDERWEIGHT TO DEATH RATES

Underweight	Death rate decrease
5 pounds	3 per cent.
15 pounds	5 per cent.
30 pounds	3 per cent.
40 pounds	Average mortality
50 pounds	6 per cent. higher

Diet.—Food is an important consideration for the middle-aged. Most people eat too heartily; meats tend to form too large a part of the diet. Excess proteins put too much work upon such excretory organs as the kidneys. Kidney diseases are very prominent in the lists of middle-aged disease, ranking one of the three main causes of illness and death (circulatory organs, kidney diseases, and cancer).

It is possible that the cumulative effects of slightly injurious

substances, such as lead, benzoic acid, or other food adulterants, may have a predisposing effect upon the diseases of middle life. Because of this, preservatives are limited by the federal government in foods entering into interstate commerce. The predisposing effects of certain occupations which naturally assume importance at this age have been dealt with elsewhere (Chapter XX).

Intestinal Disorders.—Constipation—a common middle-age difficulty—may be partly controlled by feeding. Additions such as agar (G) (which holds water tenaciously, and being quite indigestible gives bulk throughout the passage through the intestine) are helpful in many cases of constipation. Coarse foods usually have an indigestible residue; this gives bulk and has a stimulating effect on intestinal movements. Constipation is one of the most difficult situations to combat without recourse to drugs. Since these are often harmful, it is much better to stimulate the body to normal activity by modifications in the diet whenever this is possible. No treatment can compensate for the retention and absorption of harmful substances formed in the intestine. Such clogging of the intestine may lead to bacterial invasion (appendicitis, peritonitis). Natural foods, such as citrus fruits, rhubarb and grapes, help by the same fruit acids and salts which are prominent in some patented laxatives.

Effect of Illness.—Such disturbances or diseases as adenoids, indigestion, malaria, chronic colds, all have their predisposing effects, and though no serious illness may be traced to any one, they affect the tone and resistant power of the body. Mere living to an old age does not disprove this; it only proves that an individual survived in spite of such handicaps, and gives no indication of his attainments or possibilities without them. Severe illnesses are to be avoided. Intelligent, sensible people no longer cause children to contract a given disease to "have it over with." Its special *sequelæ* (deafness after measles, kidney disease after scarlet fever, etc.) are too great a risk; and the general effects cannot be predicted nor prevented. Those who reach "three score years and ten" in full vigor are not the invalids—nor those who have had many severe illnesses.

Too little attention is paid to the effects of illnesses upon the length of life. There is some truth in the saying, "To live long one must have an incurable disease"; it is readily seen that a slow

or chronic disease (which implies a certain tolerance to the disease on the part of the affected individual) usually exacts from the individual and his neighbors a degree of hygienic observance not common to the well individual.

Diseases of Middle-age.—The characteristic diseases of middle age include the "degenerative diseases," mainly diseases of the heart and blood-vessels, the kidneys, and the liver. In the order of their importance the diseases of middle age are: circulatory diseases, tuberculosis, kidney diseases, diabetes, liver diseases, and alcoholism. In 1913, diseases of the heart, blood-vessels and kidneys caused over 85,000 deaths in the registration area (G) of the United States. They are now twice as common as they were thirty years ago, while such diseases have decreased in Great Britain.

Care regarding food (including digestion and excretion) and the degree and extent of exercises are important in controlling and preventing circulatory weakness or diseases, kidney and liver diseases, and diabetes. Tuberculosis has been dealt with in a separate chapter (Chapter XIX).

Cancer.—While very little is yet known about cancer, the following statements may be useful to some of our readers. Cancer is apparently not inherited in human beings, though a tendency to cancer may be transmitted. People low in vitality or resistance are quite susceptible, as shown by the evident relation between tuberculosis and cancer. Cancer is often distinctly related to outside irritants—heat (smoker's lip cancer and cattle-brand cancers); chemicals (X-rays, and cheek cancers of the eaters of the lime-containing *buyo* of the Philippines); and mechanical irritants (soot or chimney-sweep cancer). Whether or not they are also bacterial in origin is not yet definitely known, though much work is at present being done on cancer.

The one important thing to emphasize in cancer is that cancer is curable in its early stages. Such symptoms as any unusual bleeding, swelling, especially without pain, sores of the lower lip or tongue, and irritation in warts, moles, etc., should have immediate attention. Most cases reach the surgeon a year or more after the symptoms were first noted. Nearly half of all cancer could be cured in the early stages: about 40 per cent. of the superficial cancers, and nearly 50 per cent. of the deep cancers. The percentages of cures in early and delayed operations are: breast: early, 80 per cent.;

late, 25 per cent.; lip: early, 95 per cent.; late, 60 per cent.; tongue: early, 80 per cent.; late, 15 per cent. The only sure cure is removal; X-rays may be helpful in some cases, but the use of such substances is not yet on an unchallenged basis. Medicines have no direct value.

Alarming statements are made concerning the prevalence of cancer. It is more common in women than in men, except in certain predisposing occupations. Cancer causes one death in eight in women over forty; and one in fourteen in men over forty. Between the ages of thirty-five and forty the cancer deaths are much higher among women than men, three to one. There are 75,000 deaths from cancer yearly in the United States. This increase may be due to the deferred death rate we have established; more people now reach middle age, when these diseases develop. Practically 90 per cent. of all cancer deaths are of people over forty years old. The average cancer death age is fifty-nine years, while the average tuberculosis death age is thirty-six years. Part of the increase in cancer rates is due to the better diagnosis now obtainable.

Adult Examinations or Clinics.—Because the diseases of middle age are to a great degree preventable or may be delayed by dieting, exercise, etc., all people passing thirty-five should have a thorough physical examination to enable them to make the necessary changes in habits of living. The New York City Health Department and industrial concerns, such as railroads and life insurance companies, have had their employees examined at successive intervals with promising results. At least 10 per cent. of the several hundred employees of the New York City Health Department showed "decided improvement on their second examination" by the Life Extension Institute. One great value of such periodical examinations is that people come to realize that such diseases are not necessarily fatal, that they may be prevented, or that fatalities may at least be delayed. It removes the fatalistic attitude toward kidney disease, diabetes, and even cancer formerly so common, and brings hope into the life of many an individual and family.

Large organizations, such as the Life Extension Institute, have been formed in some cities. There is great opportunity for a travelling clinic for the middle aged for the smaller towns and rural communities. Large towns should support regular clinics, with night hours for people who are not free during the daytime.

See Reference List at end of Appendix.

CHAPTER XIX

TUBERCULOSIS

Tuberculosis is discussed in a separate chapter not only because it is the most fatal of all communicable diseases, but because it is so often unrecognized in its early stages, and untreated during its development, thus increasing the fatalities in those already affected, and multiplying the new cases by needless exposure.

Tuberculosis a Menace.—How great a menace it is to our country is shown by the following figures: There are in the United States 160,000 deaths yearly from tuberculosis (Fig. 93); it causes 9 per cent. of all the deaths; every third death between sixteen and sixty is due to tuberculosis; the clinical cases are estimated as averaging ten to twenty times the deaths, making 1,600,000 to 3,200,000 cases of tuberculosis now in existence. Others have estimated that there are nearly ten million people now living in the United States who will die of tuberculosis, unless better preventive measures are enforced.

Whole countries as well as localities often pay too little attention to the spread and ravages of this disease. France, with an army death rate of tuberculosis exceeded only by typhoid, had not, at the outbreak of the war, taken any public measures to control tuberculosis, either in the army or in civilian life, and there was not for its forty million people one single governmental hospital bed for tuberculosis in all France—and but one thousand private ones.

Since tuberculosis is a preventable disease and also a curable one, it is most important that accurate information regarding these measures should be available to every individual, and especially to those who have charge of the welfare of others, particularly to mothers, teachers, and nurses. The first thing one should know is how the disease is transmitted to man.

Types of Tuberculosis.—There are two types of tuberculosis pathogenic for man: the human (Fig. 94) and the bovine. Both these types may invade various regions of the body; the most common sites in cow and in man are the lungs (Fig. 95), the alimentary canal, the glands (*e.g.*, neck, near the alimentary canal,

and in cows, the udder), bones, and joints. When open lesions or abscesses occur, organisms may leave the body in the discharges from such lesions. Commonly these bacteria leave the cow's body mainly in the fæces (Fig. 96) and milk; in man they leave mainly through the mouth discharges, though elimination with the fæces is not uncommon.

Method of Transfer to Man.—Bovine tuberculosis bacteria are eliminated with the milk, or fall into it in small pieces of manure

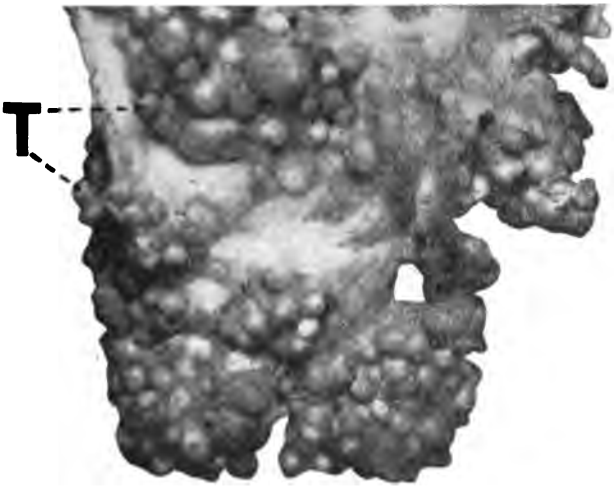

FIG. 93.—This photograph with numerous tubercles (T) on the omentum or fat layer shows the reason for the name tuberculosis.

or stable dust. Less often, tubercular meat is the conveying medium (see Meat Inspection, Chapter III). Occasionally they may be transferred to man through cuts or breaks in the skin (*e.g.*, from tuberculous udder into milker's hand), though this is less common.

Human tuberculosis bacteria may find their way into the water supply and be taken in with the drinking water; more commonly they are transferred in saliva or sputum by more direct contact (kissing, common cups, pencils, handkerchiefs, etc.), or some claim by eating food on which small particles of saliva have been recently deposited (by droplets, fingers, or flies). Tuberculosis bacteria

make their way into the next individual by way of the lungs or the alimentary canal.

Experimental work has now demonstrated that tuberculosis does not necessarily cause lesions or visible injury at the point of entrance. Tuberculosis bacteria rubbed on the skin of perfectly healthy guinea pigs caused them to die of tuberculosis of the internal organs, though autopsy showed no lesions in the skin itself. The same has been experimentally shown to be true when the entrance is through the intestinal wall, and bacteria entering in

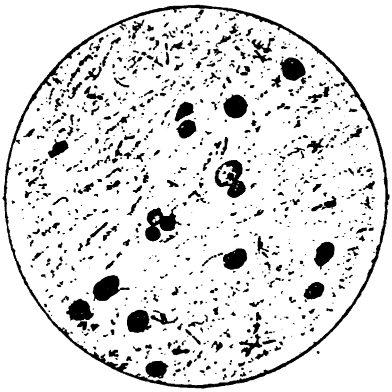

FIG. 94.—Human tuberculosis organisms and blood-corpuscles; the tubercle bacilli have retained the red stain as described in p. 214.

that way may cause pulmonary tuberculosis, tuberculosis of the neck glands, etc.

Such experiments have established the importance of bovine organisms as causes of human tuberculosis. Other proofs are found (1) in the slightly different appearance of these two organisms, the bovine organism being shorter, stouter, and less granular; and (2) in the rabbit test, for while the guinea pig is susceptible to both diseases, the rabbit is practically not affected by the human type. It takes ten to one hundred times as many of the human organisms to affect the rabbit, causing even then but a slight localized tuberculosis. Other supporting evidence is found in the high mortality of small groups of people using milk from tubercular cows

(*e.g.,* five out of fourteen girls in one boarding school died of tuberculosis).

Importance of the Bovine Type.—It is estimated that the bovine type causes 7 per cent. of all human tuberculosis. Children are more susceptible than adults to the bovine type; figures by Park and others give the following percentages for bovine infections among the tubercular: Under five years, 27 to 49 per cent.; be-

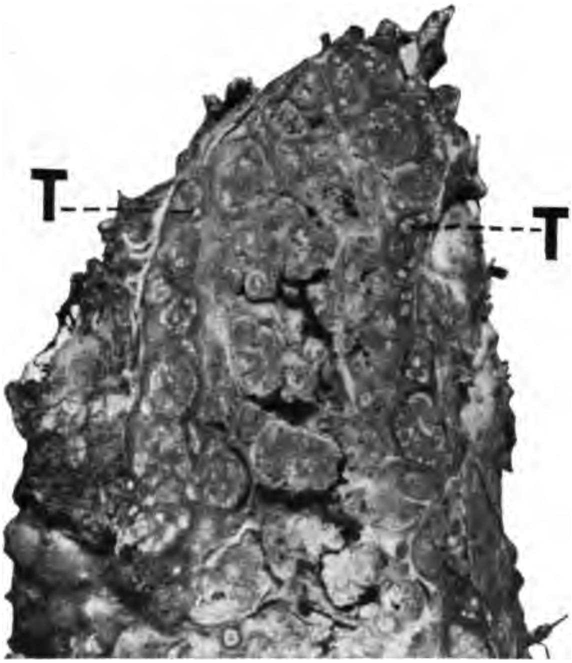

FIG. 95.—Lung cut across, showing the tubercles, T, or hardened areas containing tuberculosis organisms. How would this affect lung absorption of oxygen?

tween five and sixteen years, 16 to 25 per cent.; and above sixteen years, about 1 per cent.

The bovine type probably enters through the tonsils and the small intestine; it is associated commonly with tuberculosis of the neck glands, or in the region of the alimentary canal, less often with bone and joint infections, and practically never with lung infections.

Protection Against the Bovine Type.—Protection from the bovine type is secured by pasteurizing the milk. This should always be done, unless the milk is from animals tested for tuberculosis. (See Tests, p. 308.) Apparently healthy animals may be tubercular. Cows should be tested at least once a year, preferably twice a year, as a large number of cows are sometimes found to be tubercular—usually about 14 per cent., judging from a recent report covering eighteen States. The figures for the United States are much lower than those in the European countries—where they often reach 30 to 50 per cent., apparently.

FIG. 96.—The inner surface of the intestine, showing a tuberculous patch or ulcer, U. Organisms excreted with the fæces may find their way into milk.

Human Type.—About 70 per cent. of the deaths from tuberculosis are due to pulmonary infection; these are practically all due to the human type of tuberculosis. This is easily explained by the greater opportunity for transfer from man to man. The history of

tubercular families illustrates this, especially since tuberculosis is not very often acquired before birth; most of the cases in little children must come by transfer from members of the household. One tubercular nurse, who had the habit of tasting the food of her charges, evidently caused the deaths of four little children within a very short period.

Predisposing Factors.—It is recognized that there are distinctly predisposing factors for tuberculosis. Such external conditions as dampness, are emphasized by some. Damp places or climates probably work indirectly as depressants to the general health. In sunny, dry climates bacteria die off more quickly; transfer would be less heavy and less constant in such climates, and recent experiments have shown that numbers are important in tuberculosis transfer. It takes at least ten organisms to inoculate a guinea pig in a single dose; repeated inoculations of smaller numbers may finally break down the body resistance.

Definite predisposition to disease is probably found in those who have chronic lung trouble, coughs, etc.; in those whose vitality and general resistance are low, who live or work in dust-laden or irritating atmospheres (see Chapter XX); those who are anæmic, flat-chested, or who have tubercular family histories. Such people should endeavor to counteract such tendencies or predisposing factors in every way (Fig. 97).

Closeness of Contact Important.—Each case of tuberculosis is said to average three cases of transfer. The number depends primarily upon the length and intimacy of association. About 80 per cent. of those exposed to tubercular infection for long periods of time become infected; 28 per cent. of those slightly exposed, or for but short periods of time; and but 8 per cent. of those in chance or occasional contact with tubercular people. Children seem more easily affected than adults. This may be due to the more direct contact (fondling, fingers in mouth, etc.); it is partly due to the fact that most people have tuberculosis sometime during their lives, and the adult class contains, therefore, more immune individuals than we find among children.

Immunity of Adults.—Some investigators find that practically all adults respond or are positive to the tuberculin test; all over fourteen years of age give a positive reaction, according to one authority. This, with the relative immunity of adults over twenty-

Prevent the White Plague

Known as Consumption or Tuberculosis

SEEK

Fresh air all the time
Sunshine
Light, clean rooms
Well-chosen food
Ample sleep
Exercise in the open
Care of the teeth
Clean clothes
Clean body and mind
Cheerfulness

AVOID

Breathing foul air
"Sun-dodging"
Dark, dirty rooms
Careless eating
Chronic fatigue
Lack of exercise
Neglected, decaying teeth
Dust and smoke
Dissipation
Worry

Tuberculosis is curable in the early stages. It is easier to prevent than to cure
Patent medicines will not do either
200,000 deaths each year—one death every three minutes
from tuberculosis in the United States

Prepared by Dr. Thomas D. Wood, 525 West 120th Street
New York City 1918

Committee on Health Problems of National Council of Education
and American Medical Association

Chart 24

FIG. 97.—Are these rules helpful to the tubercular only?

five, is taken as indicating that practically every one is infected during childhood; such people are usually immune to tuberculosis, though later depressed vitality, strain, etc., may encourage the development of latent organisms, causing active tuberculosis. In slow diseases like tuberculosis the body often acquires a tolerance to the organisms which is most remarkable. "Time and tolerance" are slogans familiar to many a tubercular patient. When the reactions against the invading bacteria become sufficiently strong, a cure is effected; until then, a tolerant individual may at any time, by strain, worry, overwork, lack of proper food, lose his tolerance, and become very ill or die from the effects of the organisms before they can be held in check.

Prevention of Infection.—Prevention of the spread of bovine tuberculosis is a simple matter when compared with the many opportunities for the transfer of human tuberculosis. While a tubercular person with bacteria in his sputum may be a perfectly safe companion if he uses a sputum cup properly, it is not uncommon to see people who spoil it all by one careless habit. One physician forbade a tubercular mother to kiss her child; later, when with tears in her eyes the mother said to him, "Doctor, you don't know how hard it is for me to refrain from kissing my baby," the doctor stood aghast to see that she cooled every spoonful of "pap" in her own mouth before feeding it to her child. A sputum cup is little protection to the household, if the patient keeps his hands at his mouth or fails to wash them thoroughly when they are soiled with sputum, before touching common articles.

The tables on pages 65 and 174, with the details in this chapter, make the numerous opportunities for transfer of human tuberculosis perfectly clear.[1] It might help, however, to state the general rules to be observed by the tubercular and by those associated with them.

Care of the Tubercular.—Those who have the disease should consult the best authority they can secure, and follow his directions as completely and uniformly as possible. High altitudes and change

[1] Though most organisms die off rather promptly in the air (drying, sunlight), tuberculosis is usually wrapped in a covering of mucus, and such organisms have been known to survive for several months. A few may also survive in water for months. While it is not well to magnify the dangers of this dreaded disease, a recognition of these possibilities is probably wise.

of air are usually very helpful; in a few cases they may not compensate for the loneliness of the patient. Remarkable cures are daily wrought right at home in many cases by outdoor living, proper food, etc. Every effort should be made to make the tubercular realize that this is a curable disease, for cheerfulness has an important effect.

Community Action.—Provision should be made for the care of those financially unable to provide suitable and adequate care for themselves. This will include sanatoriums for the serious or urgent cases, clinics and dispensaries for diagnosis, advice and treatment of suspected and beginning cases, day camps for some, night camps for those who must work, and nurses or other medical aid for visiting homes, and for school and factory inspection. Open-room or open-air schools are also valuable aids. So are farm colonies for those recovering from tuberculosis. The poorest counties could arrange for occasional visits from a travelling clinic force, if such were organized by the State or philanthropic organizations. But financial help will be necessary in many cases to care for the tubercular. They are tubercular because they *are* poor, usually. Crowded, poorly ventilated and poorly lighted quarters, insufficient food, overwork and overworry are strong predisposing factors, and the health problem becomes not only a bigger health problem but a great economic one as well, if the tubercular are not cured and the non-tubercular are not protected. No community can afford to let tuberculosis increase. Reduced efficiency, death, debt, dependent children are but a few of the economic problems that accompany the tuberculosis problem. While the outlook is encouraging (Fig. 98), the figures do not warrant any cessation in vigilance in combating this disease.

Health News (1914) describes a typical case which illustrates this. A painter with three children received an early diagnosis of tuberculosis. He tried in vain to enter the State institutions, but they were too crowded. Lacking money, he was not properly cared for at home, and died. The slender savings had been exhausted, and the overworked wife contracted the same disease and died within the year, while she and her children were "on the town. If the county had had a hospital that father would have had a chance for life. At least he could have saved his wife the burden of his care, and her infection might have been avoided. In either event, if he

had lived, or if his wife had lived, the family in all probability would not have become town charges.

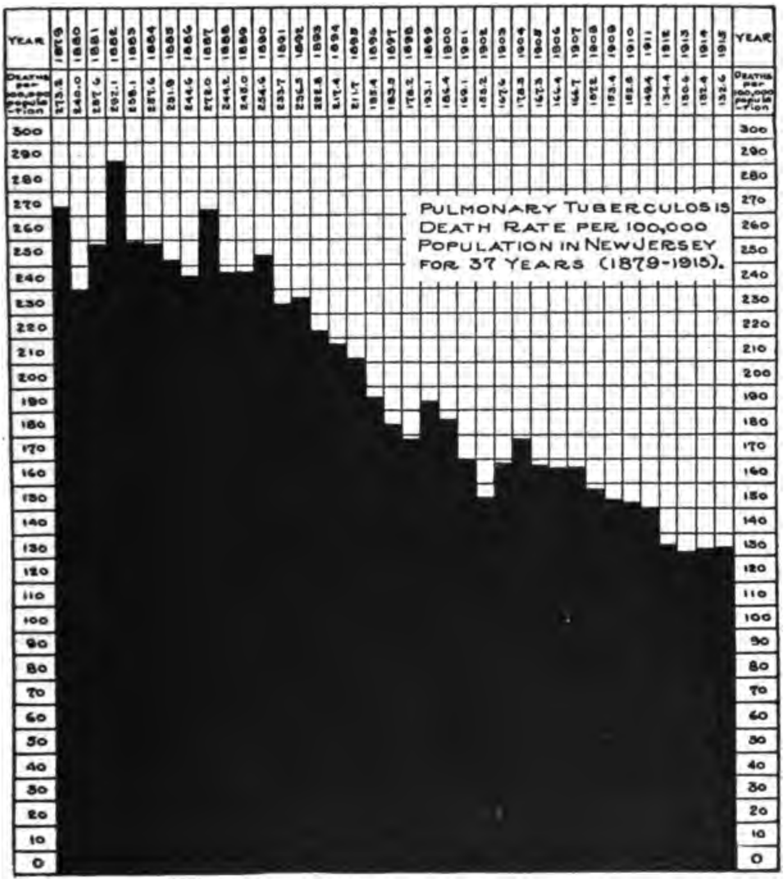

FIG. 98.—What can we do to increase this encouraging outlook?

"But there is a practical taxpayer's interest also in this story. If the county had had a hospital the effect of this man's illness on the tax levy would have been as follows:

One year's care in the county hospital, at $10 per week	$520
Less patient's contribution to his own support	200
Balance paid by county	$320

"There was no hospital whatever, so the father and the mother died, and this is the way the public account stands:

Care of father	Nothing
Mother's doctor's bills paid by town	$50
Support of family during mother's illness	50
Funeral expenses of mother	25
Care of 2-year-old child in orphan asylum for twelve years	1800
Care of 4-year-old child in orphan asylum for ten years	1500
Care of 5-year-old child in orphan asylum for nine years	1350
Total	$4775

"In other words, that county by saving $320, the theoretical cost of caring for the father, will be the ultimate loser by $4455, the cost of caring for the mother and her orphans minus the theoretical cost to the county if the father had received care."

The National Committee for the Prevention of Tuberculosis has done a great work by its leadership in stimulating practical measures to control that disease; even the Christmas seals keep the problem before the people and give a higher sanction to local movements that is distinctly helpful. But local societies are needed partly to secure full registration of this disease and to pick out the otherwise unknown cases, and to provide adequate local facilities for treatment, since it is often difficult to get people to go far from home (see Chapter XXV).

After the community has become interested and care has been made possible by legislation or philanthropy, there are still three things to do. (1) The tubercular should realize his responsibility toward others, and conform to laws of safety regarding isolation, if necessary; more often his duty will lie in the painstaking and annoying details regarding the care of discharges, washing of hands, etc. (Sputum cups should be burned; and if handkerchiefs are not burned, they should be boiled before they are put with the laundry.) A waiter or a piece worker working at a task where others handle constantly the materials he has handled may find it difficult to see that it is his duty to cease such work and find other employment.

(2) The second task is similar, though it deals with those not

yet definitely proven to have the disease. The "rather-not-know's" are all too common. They are needlessly risking their own lives, for early stages are more easily cured, and they are probably injuring many others. It is a selfish attitude and should be recognized and condemned as such. Every effort should be made to encourage and secure an early diagnosis of this disease.

(3) The third task consists in forming in the well certain fixed habits calculated to prevent the contraction of tuberculosis. This, too, is not easy, for usually it is only the burnt child that really dreads the fire. But the well, especially those with a predisposition toward tuberculosis, should adopt many of the recommendations for the tubercular—so alike are prevention and cure. Contact with the infecting organisms should be avoided, even at the risk of appearing unsociable or "fussy." Predisposing factors should also be avoided: physical strain, such as overwork, mental strain and worry, lack of sleep, improper and insufficient diets, occupations with dusty or irritating atmospheres or demanding cramped chest positions. Each one should practice the hygienic observances known to be aids to health: these relate mainly to bathing, suitable physical exercise or labor, and fresh air or, preferably, an outdoor life (even at night), if possible without overexposure (Fig. 97).

Inherited Tuberculosis.—The question of the hereditary character of tuberculosis often comes up. Tuberculosis organisms have never been seen in the reproductive cells. Occasionally the disease may be transferred before birth, however. Whether or not the disease is acquired before or after birth is usually a minor matter, as the opportunities for infection after birth are so numerous in tubercular homes—especially for little children. It is hardly conceivable that a tubercular mother could avoid the frequent transfer of tuberculosis bacteria to the child by her saliva-infected fingers or objects that they have touched, spoons, nipples, etc. To avoid such transfer demands more thought and time than busy mothers of small children feel they can give.

Immunity.—The immunity that seems to follow earlier cases of tuberculosis has been expressed by saying, "Only the tubercular are immune to tuberculosis." That is no argument for subjecting children to tuberculosis, for "latent tuberculosis" is thought responsible for the majority of the cases developing in individuals

over eighteen, and it is in the age group of twenty to thirty that we find our highest fatality rate.

Tuberculin.—Tuberculin seems less valuable in diagnosing human disease than bovine tuberculosis. If the characteristic inflammation and fever develop, it indicates only a focus of infection —probably an old or encysted one—not necessarily that disease is really present. Most adults, it is claimed, give positive reactions, owing to childhood infections. Advanced cases may fail to give the reaction entirely. For cows, however, the tuberculin test is considered very helpful—over 95 per cent. accurate.

The use of tuberculin in treating tuberculosis patients has been highly advocated; but its use is apparently attended by very real dangers, and should not be attempted, except in sanatoriums or hospitals with trained physicians in attendance. Repeated doses of such foreign substances have been found very dangerous. Its effects may be not unlike the injurious results that sometimes attend a second dose of antitoxin (see Anaphylaxis).

PROBLEMS

1. (a) Make a list of rules designed to prevent a tubercular person from transmitting tuberculosis to his family. (b) Make a similar set for the family living with the patient.
2. How many tubercular people in your neighborhood are without treatment or medical care?
3. How many of the charity cases in your locality are tubercular or have a tubercular history?
4. Make a set of rules regarding tuberculosis for distribution in the grammar school or first eight grades.
5. Write an editorial designed to influence the "solid business men" of your town to establish a tuberculosis clinic and dispensary.
6. Send to your State department of health for their pamphlet on prevention of tuberculosis. New York, New Jersey, Massachusetts and several other States have pamphlets for teachers (or for school children). If your State has none prepare one, submitting it to the State health department, and see that it or a better one is issued by the State.
7. Read An Autobiography, by E. L. Trudeau; what do you consider the most interesting contribution of this sick man to science and health?

See Reference List at end of Appendix.

CHAPTER XX

INDUSTRIAL AND OCCUPATIONAL HYGIENE

Our occupations may affect our health most intimately. These effects are of five main types: (1) Those favoring the transfer of pathogenic micro-organisms, for example, hookworm among miners; (2) those caused by irritating chemicals or drugs, such as lead in the dust freed in polishing the leaded surfaces of pottery; (3) those causes depressing the general vitality, such as intense heat or damp, dark surroundings; (4) fatigue, which, like the last mentioned type, predisposes to disease through effect on general vitality and also increases liability to accidents; and (5) accidents, including those of the specially dangerous occupations, such as railroading. An abbreviated list of the best known irritating factors and the conditions under which they usually operate is given below.

It must be recognized, however, that the diseases and deaths credited to a given occupation or condition are not always correct. Sick people, such as the tubercular and men who break down in one occupation, often drift into work less strenuous, such as cigar making or mechanical occupations. This raises the death rates in certain occupations; it also gives a false impression of the predisposing effect of those occupations to certain diseases (*e.g.,* tuberculosis).

Value of Legislation.—Increases in the accident rate, in the illness percentages, and in the earlier death ages are all injurious economically to any community. These industrial conditions, therefore, cannot be left to the employer. There are, unfortunately, a few who would prefer to save on gas masks, safety brakes, fly-wheel or belt protectors, or lighting or ventilating systems at the expense of human life.

Neither are the employees wholly satisfactory guardians of their own health and safety. Labor organizations have done much to improve their own economic conditions, and occasionally the hygienic side receives attention, but very often legislative and other improvements have been left to the initiation of others. This is sometimes due to ignorance, to seeing the present large and the future small, to a lack of respect for other human life. Ignorance

Cause or condition	Occupations or workers	Remarks
Anthrax	Workers with fur, hides, bristles	Occasionally traced even to finished shaving brush or furs ready to wear
Hookworm	Miners; if non-disinfected excreta containing hookworm is left exposed	50–80 per cent. infected in a few States
Tuberculosis	Any dusty occupation, flour-making to stone-cutting	Pulmonary tuberculosis, with a record of but 2 per cent. of non-dusty occupations, reaches 8 per cent. for tobacco dust, 14 per cent. for porcelain dust, and 34 per cent. for stone dust
Wood alcohol	When substituted for ordinary alcohol, as in dissolving shellac for stiffening derby hats	Used also in quick drying paints, insecticides, etc.
Lead	Any lead-dust trade; painting, especially where polishing is involved; lead glazing on pottery and enamel ware; making white lead; "tin foil" wrapping	Paralysis, especially of the hand, is common. About a dozen other industrial poisons are used in paints
White phosphorus	Match-making	Not used in "safety" matches. Not used in U. S. since Belgian process use of non-poisonous form of phosphorus
Arsenic	Makers and users of arsenic dyes, in clothing, furniture, carpets, cheap wines and candy; and furs cured by arsenic method	Not limited to green dyes, but dyes of practically every ordinary color
Mercury	Making of thermometers, incandescent lamps, felts for stiff hats, and treating furs	
Carbon monoxide	Workers in mines, or at coke ovens, blast-furnaces	
Dust	Workers in textiles and fibres, wood flour, tobacco, paper, coal, iron, and stone	Most irritating kinds due to (1) liberated chemicals (as in boxwood for rulers, shuttles) or (2) to sharp edges (iron and stone dust)
Excessive moisture	Laundries and textile and twine factories	Produces skin affections, predisposes to rheumatism and respiratory diseases (?). See p. 286, also

Cause or condition	Occupations or workers	Remarks
Noise..........	Boiler makers, gunners and caisson workers	
Lack of light....	All doing "fine" work, as sewing, weaving	Eye diseases, extreme fatigue, digestive and other fatigue disturbances
Continued physical discomfort	Standing, bending or other uncomfortable positions	Flat feet, varicose veins, respiration and digestive disturbances, spinal curvature, etc.
Too rapid decompression	Caisson workers...........	Affects probably 90 per cent. of all workers (at least slightly [1]); fat people are especially susceptible (see p. 138)

of the blinding action of wood alcohol is the only explanation of its use by workmen; the present good explains why fathers have sometimes placed a ten-year-old boy in the mines, or a five-year-old daughter in the cotton mills; and the low value of human life is illustrated by the naïve statement of a foreigner who, when asked why he left his wife without medical attendance during a serious disease, but called in a veterinarian to doctor his cow, said: "I'd have to *buy* another cow."

How little labor is doing and how much more labor might do for itself is shown by the fact that the American Labor Year Book for 1917–18 mentions health but three times in the index, and the matter referred to covers less than seven pages.

Workmen's compensation laws and employers' liability laws have benefited both the individual and the community directly and indirectly. Employers find it cheaper to install better ventilation, protective devices, etc., than to pay compensation awards; and the individual and his family gain in health, and by the extension of his productive years. The community benefits in those same economic ways, and also in ways less easily measured, such as the higher mental and moral tone of men no longer viewed as mere material or animals to be exploited.

[1] Kober and Hanson show, however, that if the percentage of such effects is based on the number of opportunities, that is, on the number of decompressions, the percentage is less than 1 per cent.

Factory inspection is the usual method of securing the execution of such laws. Public opinion has often been a wonderful factor in enforcing as well as in framing these laws, and a stirring newspaper or magazine article has often been the main force at work.

Many workmen are very careless, refusing to take proper precautions (gas masks, rubber gloves, frequent hand washing, especially before meals), or taking undue risks in dangerous places or around unprotected machinery. (Studies of several hundred accidents showed the workmen directly responsible in over half of the cases.)

Fatigue studies with regard to the working hours per week and per day and to the number of breaks or intermissions all tend to show an increased output per hour when the worker works as he would naturally. Comprehensive studies of fatigue and efficiency made here and abroad, both before and during the war, have shown in private and government industries a lessening of efficiency with prolonged work periods. There are indications that laborers of a certain type (digging) could work ten hours a day without materially lessening their hourly output, or affecting their health. But almost all types of work involve mental strain and skill demanding alertness, keenness of vision, deftness of touch, etc. Factories working eight hours instead of ten per day, forty-four instead of fifty-four hours per week, have found both their hourly and the weekly output higher for each worker. In emergencies, the increased time can be used to advantage, but life should not be planned on that basis. Ordinary house work, with its long hours, demands some readjustment. Though there are often intervals when one can relax and go on refreshed, these may be nullified by the constant and insistent demands of children and invalids. Many homes—as far as man-saving power is concerned—are conducted along inefficient lines not tolerated in ordinary factories. The importance of happy, well housekeepers and home-makers to a community needs but to be mentioned to be realized.

How much there is to do is shown by the recent army draft, in which, according to the statement of a large labor organization, over 60 per cent. of factory youth are exempted for physical reasons. If ordinary factory conditions have such a record, what would be the record of occupations such as those discussed in this chapter?

PROBLEMS

1. Make fatigue curves of some daily or monotonous duty, *e.g.*, ironing, with and without a relaxation interval (5 minutes) every hour or every half hour.

2. Does your "head save your heels"? Show how several of the homely tasks could be more efficiently done by such a change in method?

3. A clever objection to the above theory was made by someone who said that her heels were meant to *serve* her head, and there was no reason for tiring her brain out in planning to save steps. Can you give a good illustration for this side of the argument?

4. Which of these conditions in the table on page 316 can be improved by collecting hoods over the individual machines? By individual masks? By better general ventilation? By shorter hours? By rest intervals? Find one instance in which another remedy seems necessary.

5. What are the child-labor laws for your State? What relation have they to this question?

6. Among the important problems not touched in this chapter are the housing problems of workers in such temporary or emergency conditions as railroad or bridge construction, and munition work. Give necessary rules of sanitation for one such situation.

See Reference List at end of Appendix.

CHAPTER XXI

MENTAL HYGIENE

MENTAL defects are so different in degree as well as in kind that one brief chapter cannot give a detailed description of the types, nor an adequate discussion of the methods of treating or preventing such mental defects. Those having to face such problems must realize that this chapter can do little more than present the situation.

Types of Mental Diseases and Defects.—Mental abnormalities are commonly grouped as insane, feeble-minded, criminalistic, epileptic, or inebriate. Most of these classes can be again divided, in degree if not in type. For example, the largest group, the feeble-minded, may be sub-divided into the *idiots,* who never progress beyond the two-year stage; the *imbeciles,* whose development stops with the four-year stage; the *morons,* never developing beyond an average twelve-year-old: and a fourth class grading almost insensibly into the normal class. It is in this fourth class that we find the generally irresponsible, the ne'er-do-wells; it furnishes more of the criminals, degenerates, paupers, and drug and alcohol fiends than any other class of society. Here, too, belong " the spendthrifts, the niggards, the cranks, the visionaries, the malicious gossips, the fops, and empty people in general."

Causes of Mental Defects.—The causes of the mental defects which often appear or begin in childhood include such generally recognized causes as adenoids, malnutrition, defects in vision and hearing, and harmful home or environmental influences. Nerve fatigue (neurasthenia) and St. Vitus's dance (chorea) may lead to fixed abnormalities such as nervous twitchings, morbid ideas, undue sensitiveness, self-consciousness, etc. Any "habit twitchings," whether due to imitation (for such habits as twitching and stammering may spread rapidly through a classroom), eye defects, adenoids, or nerve fatigue should have immediate attention. Nerve fatigue has as one of its earliest symptoms increased excitability or "brightness," and this often leads to an exaggeration of this condition by continuing or increasing the strain in such "bright" children. Mental defects in older children are sometimes aggravated by

those who do not realize that forgetfulness, loss of interest in work and play, carelessness in dress or personal habits, etc., are often transitory phases of the adolescent period.

Disease as a Cause.—Disease is an important factor in mental deficiency. Rosenau states that pellagra (G) is "responsible for thousands of cases of mental disease in the localities in which it is prevalent." Syphilis is accepted as "the essential cause" of general paresis (G), which is responsible for about 13 per cent. of all first admissions to hospitals for the insane; recovery rarely, if ever, occurs among the syphilitic insane. The fact that syphilis may be transmitted even to the "third and fourth generation" indicates its importance as a cause of mental deficiency. Typhoid fever, influenza, malaria, blood poisoning, cause a small number of the mentally defective; these effects are mainly due to brain hemorrhages or local meningitis following or attending such diseases, or even measles or scarlet fever.

Other Causes.—Head injuries cause a small number of mental defects, especially insanity. These are apparently more numerous in people with predisposing habits, *e.g.,* alcoholics. Purely mental conditions, such as worry, pain, fear, and grief, are often accepted as causes. It may well be that the strength or the lack of control of such emotions is itself rather an indication of the degree of mental poise or balance. Unable to make the normal adaptations, the individual seeks refuge by avoiding his kind, or consoles or excuses himself by imagining the dead still live; that he has supreme power to change all things; that his companions are all conspiring against him, etc. Such obsessions often develop late in life, when the adjustments are greatly increased in number, variety, and importance.

Alcoholics and drug addicts are probably mentally weak or irresponsible primarily and alcoholics or "drug fiends" secondarily. Goddard says alcoholism is itself only a symptom, occurring where some form of neurotic taint exists, especially feeble-mindedness. Such habits and a weak intellect make "a vicious cycle," of course, and mental cures cannot be permanently effected, if such undesirable habits are continued; and even moderate drinking has been shown by many types of experiments to impair mental efficiency: *e.g.,* memory tests, typewriter speed and accuracy, and typesetting. Forel makes a more positive statement, claiming that alcohol is the

only cause that can be proved by statistics to give a direct new taint of mental deficiency.

Drugs apparently play a minor and, like alcohol, a secondary rôle. But one per cent. of hospital and institution admissions are attributed to drugs. This present low rate is partly due to the decreased sale of injurious drugs whether sold as such or concealed in patented medicines.

Preventive Measures.—Preventive measures may be discussed from the standpoint of the individual who is mentally defective, or with the view to decreasing the alarming numbers of mental defectives reported all through our country.

Individual Treatment.—Individuals who are known or suspected to be mentally defective should be examined thoroughly by competent physicians with the purpose of determining the degree of deficiency, and, if possible, its cause. Predisposing or causal hindrances should be removed as promptly as the physical and nervous state of the individual allows. Operations for adenoids, correct glasses, and ear treatments have had wonderful effects upon a child's attitude and his mental powers. Sometimes previous mechanical injury may make trephining (G) or a similar operation necessary to remove brain pressure and restore mental ability.

Having removed as completely as possible the physical causes, attention should be given to the other factors affecting the individual. Defective children should be cared for in a special class. This is desirable from the point of view of the normal children as well as the defective. Defectives in a classroom tend to lower the teaching standards, and unfortunate imitation habits are often acquired by the normal children. Such special classes for defectives offer opportunities for "developing their modest abilities," of forming good habits of personal care, of work and social intercourse, and of escaping the alternatives of dependency and delinquency.

Conscientious, intelligent work with the mentally deficient has established that many types of insanity are incurable. Among the feeble-minded there are many who do not progress beyond the imitative or habit stages. There are many others not usually classed as feeble-minded who can never be trusted to meet a new situation successfully, who can never be sure of standing firm on any moral issue, who can never see a situation as a whole, or in its relation to

other people or to the future. For all such, the training must of necessity be adapted to the individual's probable environment, or a favorable environment must be selected in which the individual will be most comfortable, and in which, if possible, he can become a contributing member of society.

Where the abnormality is due to shock, uncontrollable fear, etc., help is sometimes possible through "mental treatment." Fears may be dispelled and confidence may be restored by such treatment. There is grave danger, however, in some of the types of treatment now being advocated, especially for adolescents, that too great emphasis upon self may develop a degree of introspection itself harmful, especially at that age. Recourse should be made first of all to those treatments that tend to make such individuals forget themselves. It is the outside world—including other people—which should be emphasized, not the ego, which looms too large already.

Cases of St. Vitus's dance and nerve-fatigue should be withdrawn from school or protected from other exciting environments. A quiet, healthful routine should be substituted; much helpful treatment is destroyed by petty friction at home or by continual discussion of the child, his symptoms, and his sensitiveness, thus increasing often the very conditions the parents really want to cure.

Physical and nervous strain should be avoided for all on the borderland of mental instability, or with predisposing inheritances or histories. Needless exposure to diseases should be avoided, especially in individuals with delicately-balanced nervous constitutions, or whose illnesses are attended by delirium. Chronic or slowly developing disease, such as malaria and syphilis, should be treated promptly, so that the insidious poisons of such diseases shall not be continually accumulating in the system.

Census of Mental Defectives.—The following figures, based mainly on records of hospitals and similar institutions, show an alarming increase in mental defectives. This increase is real, though not so great as the figures indicate because of three things: (1) the better diagnosis methods of to-day; (2) a growing realization that mental diseases *are* diseases, and need expert treatment which can rarely be provided at home; and (3) the great change in such institutions, which are no longer prisons, but homes where the aim is to keep the patient happy and contented, and where the treatment is corrective rather than repressive.

However, the question is not the faulty lower record of the past decades, but the high proportion of mentally deficient known to exist to-day. A report of the National Committee for Mental Hygiene states that January 1, 1917, there were in the United States in the 571 institutions for feeble-minded, insane, etc., over 37,000 feeble-minded, nearly 11,000 epileptics, nearly 5000 inebriates, and over 234,000 insane, a total of over 287,000. This means nearly three people for every thousand inhabitants. This does not include all the smaller private institutions, and, of course, takes no record of many feeble-minded cared for in their own homes. This number of defectives exceeds the number of students registered in all the colleges and universities in the whole country!

The average cost of supporting such incapables is put at $175 a year per person. This does not include the economic loss to the country represented in each unproductive citizen, nor the enormous private or family expenditures. It makes the cost more real, perhaps, if we state that Massachusetts has for such cases one hospital bed for every 1400 of its population, and in recent years has spent one-sixth of the total State appropriations for the insane and feeble-minded. In 1913, in New York State one-quarter of the total State appropriations went for the same purpose. It is not too much to say that this is not the proper condition of affairs. With so many wards of normal mentality who lack food, proper shelter, education, and healthful and improving amusement and all the finer, higher opportunities that come with leisure and education, no State can afford to spend one dollar of every four on this minority of its population—on individuals who often cannot appreciate the comfort thus provided and who can never contribute to the welfare of others.

Clearly, these unfortunates must be cared for humanely. But something should be done to check the constant yearly additions to these classes of dependents. About 30,000 admissions are now made yearly to the 571 registered public and private institutions in the United States. In some States the feeble-minded are apparently increasing twice as fast as the population. What can be done to decrease this alarming condition of affairs?

Immigrant Control.—Immigrants provide an undue proportion of the insane and feeble-minded. Hundreds are deported during their first year of residence for mental diseases due to causes

antedating their arrival here. Immigrants are represented in our hospitals in higher proportions than they bear to our population. They usually have large families, and so directly and indirectly, through the dependence and inherited weaknesses of their children, they increase the numbers of the mentally deficient.

We have no definite provision for ascertaining that incoming people are free from mental disease. Adequate standards must be adopted and enforced. When it is put plainly as "a question whether we or the foreign steamship agents shall select the parents of future generations of Americans," there can be but one answer.

Any method dealing adequately with the problems of mental deficiency must recognize that feeble-mindedness and insanity may be inherited. Several investigations, each including several hundred patients, showed family histories of mental disease in more than half the feeble-minded and insane; the proportion of family histories with mental disease is but 3 to 8 per cent. in normal individuals. It is not easy to trace the ancestry of the illegitimate and dependent offspring unfortunately so common among the descendants of the feeble-minded; were they more complete, considerably more than half might be found with histories of mental diseases.

Scientific investigations have enabled students in this field to predict with considerable accuracy the degree in which certain defects will be inherited. Certain defects tend to disappear when mated with normal individuals; other defects may be confidently expected in the first generation. Marriage of two people who are apparently normal, but who have a similar family taint, may lead to abnormal offspring. Marriage of people closely related by blood often brings to the surface unsuspected defects, such as blindness, deaf-mutism, idiocy, insanity, and intellectual dullness. It is essential that an individual with a questionable family history should consult a competent specialist before deciding to rear a family. His decision may allay secret fears that would otherwise haunt the individual for years. Even if marriage is forbidden, the disappointment or grief cannot compare with the suffering and responsibilities associated with the problems of mentally diseased offspring. In such cases, the individual must face the issue squarely, and realize that it is not bravery to "take the risk," but that he may be re-

sponsible for years of suffering by his offspring, and inflict upon his community incalculable harm.

This is illustrated by the well-known history of the Jukes family, which so far has cost New York State more than 125 million dollars. To a lazy and irresponsible fisherman born in 1720 are traced over 1200 persons in five generations, including about 200 who married into the family. Of these, about 300 died in infancy, 310 were professional paupers, 130 were convicted criminals, 60 were habitual thieves, 7 were murderers, 440 were wrecked by venereal disease, and more than half the women led immoral lives. Not one had a common school education, and but 20 learned a trade (10 of these learning it in prison).

The damage done by a taint on one side only is illustrated by the Kallikak family described by Goddard. The Kallikak history includes two branches started by one man who married a Quakeress and so started a line of descendants, which now totals 496 members, and contains only responsible worthy citizens without any feeble-minded, criminal, or even ne'er-do-wells, except two abnormal individuals whose abnormality can be shown to be due to outside strains brought in by intermarriage. This same Kallikak ancestor before marrying the Quakeress had an illegitimate child; its mother was a feeble-minded girl. The total descendants of this feeble-minded line now number 480 individuals, many of whom cannot be traced. Among those traced are but 46 normal individuals; 82 died in infancy, 36 were illegitimate, 24 confirmed alcoholics, 3 epileptics, 34 were criminals or criminalistic, and 143 were feeble-minded.

In the Zero family we have a balance to the lesson in the Kallikak family, for a Swiss family having two lines of highly respected descendants produced by intermarriage a branch beginning with a man thereby tainted with insanity. He married a roving Italian vagrant of vicious character; and their son married a German vagabond. All their descendants were vagabonds, thieves, inebriates, or showed mental, moral, and physical defects.

Remedies.—It is evident that only the responsible will be restrained from marriage by the probability of the transfer of mental defects. The irresponsible are not restrained by such arguments. For such, various recommendations have been made: segregation, sterilization, and legislation preventing marriage of those who cannot obtain a medical license. The first two are not practicable with-

out a strong supporting public opinion. Segregation cannot be applied to all unless mental deficiency is made a notifiable disease.[2] Examining and advisory clinics are too often provided only for those who come before juvenile and criminal courts. Segregation to be adequate must be absolute and so forbid leave, home visits, etc. Surgical sterilization is now provided for in eleven States, and while it is both harmless and efficient, it has not been found practicable. Legislation demanding a medical license for marriage increases somewhat the illegitimacy rate. However, it probably prevents many an unsafe marriage, and it calls attention to the whole problem.

The only other remedy is in education and a development of a sense of personal responsibility. A country that in seven years has an increase of 79 per cent. of its feeble-minded population and of 24 per cent. in its insane population must find a solution to this problem.

PROBLEMS

1. What should be the attitude of parents toward the training or education of an abnormal child?

2. In the ordinary community what effective aid may we expect from the doctor in helping solve mental hygiene problems? From the teacher? The school nurse? From the minister? The editor? The librarian?

3. In some communities it has been customary to encourage the marriage of young feeble-minded pauper women in order to free the taxpayer of their support? Criticise this as an economic measure.

4. What institutions in your State receive the insane? Those not able to support themselves? Those wishing or able to pay for support? The criminal insane? The feeble-minded? The epileptic?

5. What per cent. of your State money goes to support the classes mentioned in Problem 4?

See Reference List at end of Appendix.

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[2] Mental deficiency should be included in the notifiable diseases. New Jersey is apparently a pioneer in this respect. We should in that way have a complete register of such diseases instead of a register including only those in institutions and hospitals.

CHAPTER XXII

MILITARY HYGIENE

Hygienic Effects of War.—War, especially the present war, has two distinct and opposite effects upon hygiene, injurious and beneficial. The injurious effects are serious ones; but since war is here, it is sensible to make the most of any benefits that may help counteract such injurious effects. The beneficial effects we can at present see are, therefore, as follows: War emphasizes and makes more or less familiar the important hygienic advances and discoveries made in the time of peace, such as the control of typhoid and venereal diseases. Even those with the very lowest sense of self-respect and personal responsibility can never wholly forget or ignore the military standards set by the federal government in such matters as care of the teeth, personal cleanliness, safe drinking waters, abstinence from alcohol, care of wounds, disposal of waste, dangers from flies and other insect carriers of disease. Lectures, educational literature, moving pictures, and enforced observance of hygienic habits all drive these home to our soldiers in camp. The experiences of the absent are of the keenest interest to the people left at home; the members of girl and boy scout organizations and the people as a whole benefit proportionately. The benefit to the individual must be recognized also. Wood says that the training camp records of even those men who have been accepted as fit "show that in multitudes of cases, and within six months after the beginning of training, the improvement in health, in vitality, in physical and general efficiency has been almost incredible."

The injurious effects are: (1) The demands of the sick and wounded tend to deflect money, nurses, and even protective legislation from the coming generation. (2) The horrors of war tend to blunt our sensibilities to the still present horrors of peace, such as infant mortality, child labor, child delinquency, and industrial and traffic accidents. (3) There is also a let-up in the battle against insect and other pests that directly (carrying disease) or indirectly (by economic relations) affect man's welfare. (4) And no one denies the effect upon the health of the coming generations when

"the best are killed" and "the worst are left at home," even though the defects that lead to exemption are not always transmissible. (5) We must also include after-war conditions: though our government is already preparing to meet the problems of the crippled and otherwise incompletely self-supporting.

Methods of Selection.—The method of selecting men for our military forces and the care of the men in the army and navy are all designed to minimize the evils of war. We will discuss briefly the principles determining the selection of men for the army,[1] and then, later, the methods of caring for them.

At all times the regulations are designed to safeguard the welfare of the men, for no army is efficient if made up of sick men. But, in times of great stress or emergency, these principles may have to be modified, or may even give way. For example, at the outbreak of the war the tocsin sounded in the little town of Poligny at half-past four one afternoon to announce the coming of the enemy. The next morning at nine 475 men marched away from that little town of 1145 people! There was no time to determine age limits or physical fitness. What wonder that tuberculosis has spread rapidly among such hastily selected armies?

When time allows, the selection of soldiers should be carefully made. Every sick soldier is a soldier less; he is also a dead weight upon his army and his country; for he requires the services of able-bodied men, he may be a focus of infection, he is a distinct money loss (previous training, feeding, hospital care), and he may be a pensioner of his government for many years.

Age.—Age is an important factor in selection. If too young, the applicant's bones have not reached their final hardness and the joints are not fully developed (hence greater fatigue in the hollow of the back, lack of proper support of weight by pelvic bones). His muscles lack endurance, and in long marches it is the boys who "fill the hospitals and encumber the roadside." The chest has not reached its full capacity, and heavy equipment or other strain may cause displacement or other injuries to the heart and lungs. Our upper limit for drafted men is thirty-one years, though older men are in the service, and older ones in good health may volunteer their services, especially in allied departments, shipbuilding, motor

[1] Army, as used throughout, for the sake of brevity, includes the whole military force—navy as well as army.

construction, etc. The "veterans" of Napoleon were twenty-six to twenty-eight years old, and his "old guard" were twenty-eight to twenty-nine. Much older men may have muscles that are too "set," depending partly on how restricted their previous work has been; they are more often affected with the nutritional and organic diseases of middle age; heart affections, hernia, kidney diseases, etc., are common disqualifications which need no explanation.

Other Physical Qualifications.—Height is also important. The limits are usually sixty-four to seventy-two inches; uniformity is quite desirable in all men who march, because of the different step length. Weight is important. While the lower limit is usually 128 pounds, 120 may be accepted, if the flesh is firm and the applicant is evidently vigorous and active. The cavalry upper limit (164) is lower, naturally, than that for other departments (190). Weight and height must, of course, be considered together.

To Napoleon we credit the saying that "battles are won with legs rather than arms." Motor trucks have not lessened the importance of human locomotion, and "getting there first" is still an important element of success. Feet are, therefore, carefully inspected, and anything which reduces the strength or springiness of the foot materially is cause for rejection (flat foot, abnormal toes and loss of important toes). "Arms" are not underrated, however, and the applicant should have sufficient fingers to manage his firearms, etc.

Teeth are most important; the minimum is usually four pairs that oppose; false teeth are easily lost or broken and are not always considered an acceptable substitute. Rejection for defective teeth (9 per cent. in one lot of 10,000 rejections) indicates that we, as a nation, have been most careless about this important aid to proper digestion of foods.

Defective eyesight caused over 21 per cent. of the exemptions in a lot of 10,000 soldiers in eight camps as reported by Crowder. Eyesight is more important than in any previous war; fighting on land and sea is done at such long range against odds before unknown (*e.g.,* protective coloring, camouflage, heads only visible behind trenches). The usual hearing standard is ability to distinguish words spoken in a low voice at a distance of 50 feet. Corrective treatment may be given for defects of the eye, ear, nose, and teeth, if the men are otherwise acceptable.

Nervous instability and mental affections have never been more important causes of rejection than in this present war, with its multiplied and refined horrors.

Special requirements are made for service in special departments; for example, aviation demands unusually keen eyesight, a strong heart, elastic lungs, less sensitive or less easily irritated mucous membranes (nose, etc.), and a positive sense of balance and direction.

Entrance Treatment for Communicable Diseases.—Communicable diseases are causes for rejection in time of peace; now there is a general tendency to accept men in curable stages of certain diseases, placing them in special squads during treatment. Such treatment is now accorded meningitis carriers [2] and those having gonorrhea or syphilis.

Rejection Figures.—The exemptions in order of importance, as given by various military authorities, differ with the conditions of peace or war, and with the sanitary progress of the times, that is, our ability to cure or cope with certain diseases. The order in importance of the main causes for 1898, for example, was defective development (25 per cent.), defective eyesight, circulatory diseases, genital-urinary diseases, digestive diseases, bad character, deafness. In the present enlistment Crowder's report on eight camps (10,000 rejections) gives the order as eyes (21 per cent.), teeth (9 per cent.), hernia (7 per cent.), heart disease (6 per cent.), ear (6 per cent.), tuberculosis (5 per cent.), defective development (4 per cent.), venereal disease (4 per cent.),[3] mentally deficient (4 per cent.), etc.

Having selected soldiers of good general health and resistance, and protected them against the diseases common in military experience, the next problem is to keep them well, despite the strain and dangers of warfare. In military as well as in civil life, the emphasis is on prevention rather than treatment.

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[2] Disinfectants may be applied directly to the nasal membranes. Better results seem to be secured by inhaling certain drugs (*e.g.*, chloramin). In most carriers the organisms die off in about a month.

[3] This does not include all the actual applicants. Those with evident physical defects or in advanced stages of venereal disease may be rejected in the regular physical examination. Present estimates indicate that if preliminary selection had not been adopted the rate would approach 30 per cent.

It is, of course, impossible to describe in one chapter the sanitation details practiced in the army and navy. They deal chiefly with clothing, bathing, water, food, care of the body (including the feet), and prevention as well as treatment of communicable and insect-borne diseases and the treatment of wounds.

Clothing.—The clothing is mainly of wool,[4] chiefly because wool (1) is warmer (numerous air spaces between the fibres); (2) gives water up slowly and is therefore less likely to chill the body as the wet clothes dry; and (3) can be made waterproof by treatment with oil (lanolin), thus replacing the "waterproofing of the original owner." Underwear is also preferably of wool, and three different weights are supplied our men. Abdominal bands of woolen material are used commonly to prevent chilling of the abdomen and predisposition to intestinal diseases. Socks of three different weights are usually used, one being cotton. The average life of a sock is 50 to 80 road miles. (Some of the European armies use pieces of cloth or long strips of cloth instead of stockings, claiming they are less liable to cause blisters; some use a coating of grease only.) The American army has a good type of shoe—flat-soled, flexible leather, shaped more like the natural shape of the foot, with the median line running through the big toe to the middle of the heel. Shoes are usually treated with shoemaker's dubbing (equal parts linseed oil and dissolved rubber) to make them waterproof. Twenty-five per cent. of the marching men suffer with foot troubles during the first ten days. Frequent changes of socks (as at midday halts), lessening of the perspiration,[5] and decreasing the friction (talcum powder) are all important aids.

How important good shoes are one rarely realizes, until one reads that, except on asphalt or other made roads, large armies always march in dust or mud. Dirt moist enough not to fly up as dust is quickly compressed into mud.

[4] Recently there has been great excitement over *shoddy* or used-over wool. A good part of *all* woolen goods is said to be made of old, used fibres; the price would probably be prohibitive, if such renovated wool were not used. It can, of course, be cleaned thoroughly, and be made as safe and as sanitary as fresh fibres can. Merino is really one-third cotton, but is commonly thought of as woolen goods.

[5] Feet may be toughened by soaking them in warm solution of alum or salt. Perspiration may be directly affected by zinc or salicylic acid ointment. Sometimes the talcum is mixed with salicylic acid (talc 87 parts, starch 10 parts, and salicylic acid 3 parts).

Blankets are often made waterproof by soaking in linseed oil, or by alternate soakings in aluminum sulphate and soap. Rubber surfaces are sometimes applied. While materials so treated are invaluable for occasional use (driving rains), or for bedding (to keep out ground moisture), they are not desirable for clothing, as they keep in the heat and perspiration.

Bathing.—Bathing is required; the feet or other chafed parts being specially cared for at noon halts, etc. At camps ingenious bathing facilities have been improvised (*e.g.*, a barrel with holes) for giving a shower bath. In regions where water is scarce, the bathing water is sometimes collected, treated with lime to throw down or precipitate the soap and dirt, passed through settling tanks, and treated in the third or last tank with washing soda to precipitate the lime; oily material is skimmed off the surface by cloth strainers, and the water is then passed through a charcoal filter and stored in a temporary tank until used. By this method it is possible to get a good bathing water, odorless, clean-looking, and capable of a good lather. It is possible in this way, with 2000 to 4000 gallons of water, to afford shower facilities for 2000 a day. The sediment or sludge is buried, and the water can in this way be used an indefinite number of times.

The socks are washed daily, when the feet are washed. If the underclothing cannot be washed daily, it should be at least aired and dried and rubbed to remove dust, etc.

Drinking Water.—Drinking water is a great problem, naturally. Each soldier has a canteen, which is scalded thoroughly when new and occasionally thereafter. He is warned to drink little while marching, especially during the early part of the marches, as that often leads to drinking water from other and often unsafe sources later in the day. (The exchange of canteens is, of course, to be discouraged. It would also be a help if the distinction between necessity-thirst and habit-thirst drawn by Ford could be made clear.)

In enemy country where wells are often filled up or dynamited good well water is scarce. In the present war they have been found to be contaminated with disease organisms or filth, such as human or barnyard wastes. At all times surface streams or lakes receive drainage from unknown or unprotected regions. The problems are, therefore, (1) securing enough water; and (2) insuring its safety. Even in hospitals and camps in our own country water has been a great problem in this present war.

On the march canteens may occasionally be filled directly from the streams, the animals being watered below, and washing, etc., being done still further down stream. Drinking or canteen water should be boiled or chemically treated in the great majority of conditions. It may be boiled in huge kettles and cooled over night for the next day's supply. The navy distills its water from the ocean.

Chemical Water Treatment.—Chemical treatment is the usual method in our own army. We have two main methods which seem satisfactory. One is the Darnell filter method—a combination of chemical precipitation and filtration. Alum and sodium carbonate are used as precipitating agents, in proportions of about one pound to five hundred gallons of water. This apparatus has for bacterial removal an efficiency of about 90 to 95 per cent. As shown by the description accompanying the diagram (Fig. 99), it is easy to operate, and is easily transported, put up, etc.

The second method is primarily chemical, though in the case of a very muddy water it may be first filtered. Our army uses for this purpose the Lyster bag, a waterproof canvas bag with several faucets at the bottom. To this bag containing forty gallons of water is added one gram of chlorinated lime (see Appendix), which is kept in one-gram bottles or capsules ready for this use. This is a rather stronger solution than is used in city water supplies, being somewhat over three parts to a million parts of water. In half an hour the water may be used for drinking purposes. Water wagons are also used; they are essentially tanks to which chlorinated lime can be added, and have the added advantage of locomotion. One water wagon holds 125 gallons.

Disposal of Waste.—The disposal of human excreta is a big problem, especially in trench life.[6] There, special boxes with metal

[6] The hardships of life in the trenches are real to most of us, but we fail, usually, to appreciate fully the hygienic problems. In the covered trenches, men are sometimes 30 to 40 feet underground without sunlight, and with barely room to stand erect. But even the open ones have serious problems; standing water, mud, the problems of excreta disposal, and such pests as rats and insects (flies from No Man's Land, lice, etc.). Men are crowded in very small quarters, often one man to a square yard, which may be raised to four or more in time of actual combat. The periods in the trenches are as short as the circumstances permit—usually about a week, however. With all these handicaps, there has been surprisingly little sickness, due primarily to the practical elimination of intestinal disorders by vaccines.

receptacles are used as latrines (G); these cans are emptied at least daily, the contents being taken back of the trench lines, often several miles. Separate cans are often provided as urinals, to simplify the process of burial, disinfection, etc. On the march or in temporary camps pits or trenches are used where the conditions permit (*e.g.*, where the soil is not too rocky). These are as far from the

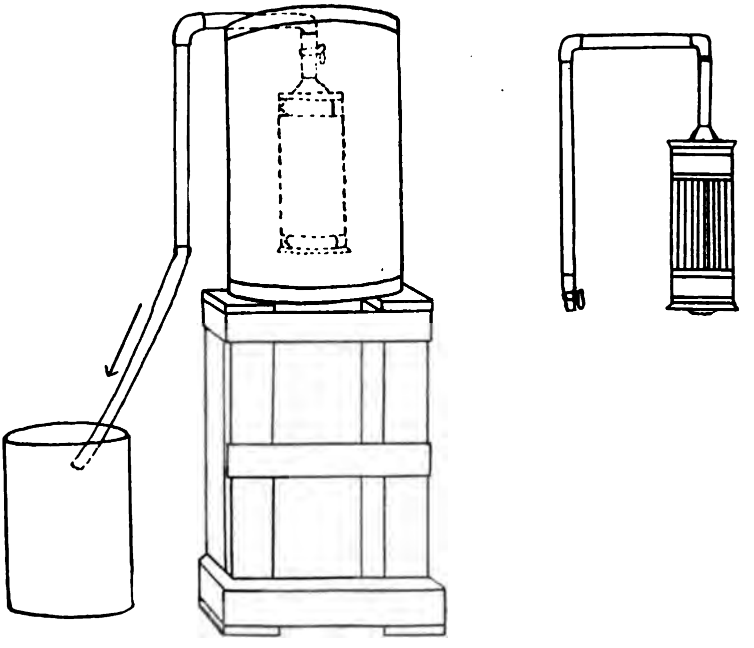

Fig. 99.—Water filter in use in the United States Army. In use, a canton flannel cover is placed over the frame shown on the right.

kitchens as possible, to eliminate fly transfer of typhoid, dysentery, etc. These pits or trenches vary greatly with the permanence of the camp. They may be simply soft dirt trenches, they may have a loose wall or drainage base, or they may even have wooden or screened tops, with covers so adjusted that they fall shut when not held open (Fig. 100). Garbage is similarly disposed of, usually. Garbage and latrine pits may be simply filled with dirt, taking care that the edges are free from objectionable material. These edges and the pits themselves are sometimes treated with chemical

disinfectants, such as lime. More often the pits are burned out instead, first flooding them with crude oil. Sometimes these pits, especially the garbage pits when designed for long periods of use, are specially constructed to facilitate the burning process (*e.g.,* loose rock piles which allow the liquids to drain into the ground, and provide better aëration for the burning of the solids; see p. 167).

Food.—The bacterial phases of the food problem (*e.g.,* when prepared by cooks infected with dysentery) are discussed separately under transfer of disease (Chapter IX).

The mechanical phases of food preparation are those of the ordi-

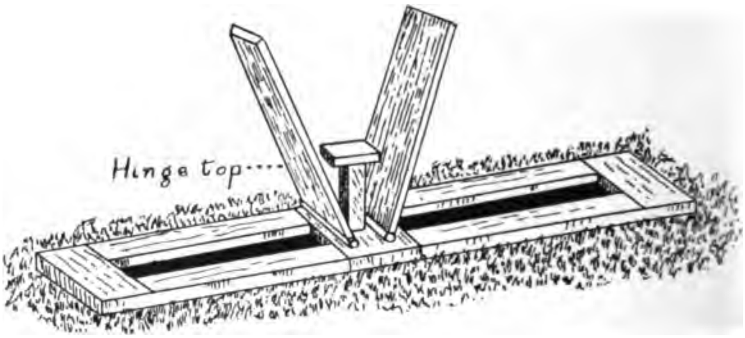

FIG. 100.—Pit or latrine cover; the central block prevents the lids from staying open.

nary home or hotel. Dishes should be washed thoroughly, refuse should be entirely removed or destroyed, uncooked foods should be washed unless served from original wrappings or packages.

Food should meet the requirements already discussed in Chapter III, on Food. The effect of appearance and flavor on digestion, the necessity for enough food, and the right kinds of foods, need not be repeated here. We find the training camps substituting vegetables for other foods whenever possible. But vegetables and milk probably do not figure as largely in the dietaries as might be possible. But the aim of the government is efficient fighting men, and it has long been recognized that "an army travels on its stomach as well as its feet," and every effort is made to provide an adequate diet.

Army Rations.—Very contradictory statements are made by soldiers and even by texts concerning military rations.[7] The army

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[7] A ration is the food allowance for one day.

and navy rations differ; another reason is that we have all possible camp modifications of the standard diet, which is roughly 11 per cent. protein, 10 per cent. fat, 46 per cent. sugars and starches, and the balance water, minerals and indigestible material. Another reason for the different reports is that the army, for example, has five rations: a garrison ration, a travel ration, a reserve ration, a field ration, and an emergency ration. The field supply trains each carry at least two field rations for each man. Each man carries in his kit two reserve rations; these are not to be used except when so directed by the commanding officer (see following table).

AMERICAN ARMY RATIONS

Garrison ration		Field ration		Reserve ration		Travel ration	
Article	*oz.*	*Article*	*oz.*	*Article*	*oz.*	*Article*	*oz.*
Beef	20	Beef	14			Beef, corned	12
		Bacon	3.6	Bacon	12		
Flour or bread	18	Bread	16	Hard bread	16	Bread	18
Baking powder	.08						
Beans	2.4	Beans	4			Beans, baked	4
Potatoes	20	Potatoes	14				
		Tomatoes	5			Tomatoes	8
Prunes	1.28	Prunes	1.28			Jam	1.4
Coffee	1.12	Coffee	1.12	Coffee	1.12	Coffee	1.12
Sugar	3.2	Sugar	2.4	Sugar	2.4	Sugar	2.4
Milk (evap.)	0.5					Milk (evap.)	.5
Vinegar	.16 gill						
Salt	.64	Salt	.16	Salt	.16		
Pepper, black	.04	Pepper	.02				
Cinnamon	.014						
Lard	.64						
Butter	.5						
Syrup	.32 gill						
Lemon extract	.014						
Approximate net total	69 oz.		62 oz.		32 oz.		47 oz.

Emergency ration

8 oz.—divided into 3 cakes, sealed tin can:
- 45 per cent. chocolate liquor
- 7 per cent. nucleocasein
- 7 per cent. malted milk
- 15 per cent. egg albumin
- 22 per cent. powdered cane sugar
- 4 per cent. cocoa butter
- balance water

Another concentrated food of high value is pemmican: dried lean beef tallow, currants, sugar, pressed into cakes supplemented by chocolate.

While travelling these diets may be left partly to the soldier; he has, for example, a cash allowance as "hot-coffee money."

The standard ration is about 5000 calories a day. This is fixed by Congress, but the ration is flexible as to the items composing the diet. For example, in the garrison ration beans may be replaced by rice or hominy; prunes by peaches, apples, or jam; vinegar by pickles; or beef by mutton (20 ounces), bacon (12 ounces), dried fish (14 ounces), chicken (16 ounces), etc.

Prevention of Disease.—The regulations already discussed show that in military as well as civil life the "ounce of prevention is worth a pound of cure." The men selected must be well and hardy. Food, clothing, exercise, and body care must help keep them fit. Garbage and other wastes must be disposed of in such ways that they are not a menace to health.

The regulations also forbid drinking water from unauthorized sources, and buying food (unless in original packages) from unlicensed venders, since the danger from such diseases as typhoid, dysentery, and tuberculosis is so great.

Disease is also guarded against in more definite ways. Men infected with communicable diseases are either rejected or segregated during curative treatment (see p. 331).

Typhoid and dysentery carriers are not allowed to prepare food. All men are vaccinated against smallpox, even if they have been previously vaccinated. Every man is also vaccinated against typhoid. This typhoid vaccine, contrary to usual practice, is now given our men in one dose; this is a special glycerin combination found to be as successful as the several injections formerly used. Mixed with it we give killed paratyphoid (G) organisms and killed dysentery organisms. It is, however, commonly spoken of by the men as *typhoid vaccine,* for many of them do not realize that it is a triple vaccine (see p. 203).

Some responsibility is put upon the men for keeping well. There are bi-monthly physical examinations and those suffering from venereal disease must report for treatment; failure so to report is a court-martial offence; men not on duty (or on sick leave) receive no pay when alcohol or venereal diseases are the causes.

Losses from Disease.—It is generally known that formerly diseases, such as typhoid, caused more of the war losses than the accidents of battle (including the killed and mortally wounded). In

our own Civil War the deaths from disease among the white soldiers were nearly twice the other deaths; among the negro soldiers they were nearly nine times as many. The Spanish-American War was relatively short, and physical exhaustion must have played a minor part as a predisposing factor, yet the ratio there was almost six to one.

In each of several of the recent wars, however, the Franco-Prussian, the Russo-Japanese, and the Boer War, one or more of the participating countries demonstrated that it was possible to

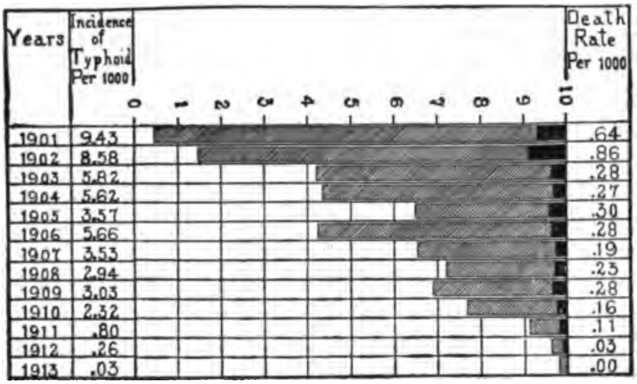

FIG. 101.—Typhoid is now relatively unimportant as an army disease. Why?

reduce markedly the deaths from disease. In our recent Mexican difficulties the typhoid figures—but one case (or two?) among over 12,000 soldiers—showed that control was possible even under such unusual difficulties as limited water supply, difficult climatic conditions, and all the problems of long-distance transportation (see also Fig. 101).

Typhus Fever.—Having established the value of sanitary control of food, water, human wastes, etc., and of such immunizing methods as vaccination against dysentery, typhoid, smallpox, cholera, and even plague, we were hardly prepared for the death rates from typhus fever in the early part of the present war. Knowing that the disease is spread by the body louse (and also by the head louse) has made possible the control of that disease. The head is shaven

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—at least the part near the neck; nurses and doctors wear clothes fastened tightly at the ankle and wrist, to prevent lice from reaching the body; bathing is enforced; in many parts of battle lines delousing stations are established at distances making it possible to treat each individual at short intervals—every ten days, at least. These delousing houses are little shacks supplied with hot water and steam, and usually consist of four rooms or compartments. The man enters by one, hands his clothes in to a second to be sterilized while he, himself, passes to a third for a complete bath, including the head. As he passes on to the fourth room, his steam-sterilized clothes are handed to him, and he leaves the station from that fourth safe room. Several thousand can be treated each day in one of these small stations.

The typhus rates during the first two years of the war were not so much a reflection upon military sanitation as upon the peoples of Central Europe. In many of them typhus fever is endemic; louse-infested people and others sick with typhus formed part of the fleeing thousands of civilians who had to be cared for in the crudest of shelters, particularly along the southern front. The ill, the wounded, and prisoners, too, were housed in the same kind of sheds, often without any water supply at all, sleeping on straw or the floor itself, often so close together that their bodies actually touched. Such dark, often entirely windowless, shacks, without water and without privies, filled with people possessing no changes of clothing, were pest houses we cannot picture. Without drugs or medicines, the few overworked doctors and nurses in such regions struggled bravely. They, themselves, died off at a fearful rate, over 60 per cent. in some localities on the southern front. The greater stability of the battle lines has lessened the migration of infected peoples and enabled military authorities to care properly for their own soldiers as well as infected prisoners, and typhus fever may now be classed with the controlled diseases. Similar delousing stations are now in use on the western front for prevention of trench fever (see p. 341).

Tuberculosis.—Tuberculosis has assumed alarming proportions, especially among the French. It is low among the English, because England had met the tuberculosis problem before the war began, while in France practically nothing had been done (see p. 302). The tuberculosis rates in the French army were formerly

next to typhoid. The French army, which was mobilized in such haste and with regard to numbers only, is thought to contain over a half million tubercular cases; while the English army of over 5,000,000 men, mobilized more deliberately with physical examinations, has no real tubercular problem at all. The relative freedom of the English is attributed partly to their attitude toward fresh air and outdoor exercises.

Other War Conditions.—There are in the present war other diseases relatively new—at least in the proportions in which they exist—incident to the changed methods of warfare. "Trench fever," though rarely fatal, is serious in the total illness rates, especially as one attack does not protect against a second. Recent investigation indicates that this, like typhus fever, is a louse-borne disease. It may be a "short fever of about a week's duration," often followed by a short, single relapse; or it may be a longer illness with a number of sharp, periodic relapses. It is not relapsing fever, with which it has been confused.

"Trench foot" is another new disease, traceable probably to exposure (cold, mud, slush), but mainly to muscular inactivity, due to the confined trench quarters, especially in the long-sustained sitting positions where the pressure of the seat under the knees slows the circulation. The shrinkage of the woolen puttees worn by the English also restricts the circulation, predisposing to this disease.

Other war diseases are infectious jaundice (Weil's disease), causing but a low mortality (2 to 3 per cent. of those infected), and war or trench nephritis (G); the latter, while not often fatal, is important as an epidemic disease, and because it tends to show up later in kidney disturbances. Kidney diseases are so important in adult life that such predisposing factors must be looked upon as dangerous. It is thought that infectious jaundice is a disease transferred through the rat; the cause of war nephritis is as yet wholly unknown.

Nervous Disorders.—Functional nervous disturbance, such as blindness, deafness, insanity, and paralysis due mainly, if not entirely, to shell shock, and nervous exhaustion due to extreme or continued strain, have been more prominent in the present war than in any earlier war, with its new and terrible methods of warfare.

Gas Poisons.—Gas poisons, such as chlorine, are mainly in-

jurious because of their effect upon the delicate membranes, eyes, nasal passages, lungs. They cause pain (*e.g.*, smarting of the eyes), or such a copious flow of secretions to remove the exciting substances that these secretions interfere with sight, or clog the lung membranes, thus interfering with breathing, and often causing suffocation for lack of oxygen. Carbon monoxide used in explosives may be responsible for many cases of gas poisoning (see CO, p. 132).

Occasionally milder nauseating gases are used. These are important only because they cause the removal of the protective masks, leaving the men unprotected for the subsequent attack of more irritating gases.

The meeting of the gas problem is one of the thrilling episodes of the war. When first used in 1915, the Allies were wholly unprepared and a hasty conference was called in England. Procedures were agreed upon, factories commandeered, and thousands of masks were conveyed across the Channel and in use in France in less than seventy-two hours after the conference met.

Wound Treatment.—The treatment of wounds deserves a chapter by itself, for they have always been a big item in the losses due to war. Before Lister's work just after our Civil War, surgery was in the same deplorable state it had always been: over 99 per cent. of all abdominal operations were fatal; so were over 60 per cent. of all other major operations, such as the removal of a leg or an arm. One surgeon in the Civil War was seen to clean his knife on his boot before using it to cut off the leg of a wounded soldier.

That bacteria were present in wound infections was not positively shown until 1866 to 1877, though such theories were advanced earlier than that, and supporting evidence was given by Oliver Wendell Holmes in 1843. Bacteria were not seen in animal tissues until 1849, and not in human blood or (human) tissues until 1866. It was commonly thought that suppuration was an early and even necessary stage in healing; and occasionally one still hears it said of a wound that "It must grow worse before it can grow better."

Since Lister's work with disinfectants and antiseptics, wounds have been treated very differently. His work has made possible all the marvels of modern surgery. Every effort is made to keep the wounds free from bacteria.

Our soldiers are supplied with first-aid packets, containing usually two bandages and two compresses made of dry gauze soaked in corrosive sublimate, and two safety pins. (These are wrapped in waxed paper to keep them sterile.)

In the present war, wound infections have been an unexpectedly serious problem, because of two things; the type of wounds commonly found and the kinds of organisms often present. Liquid fire often causes very large burned areas on the body; the explosives of to-day make wounds which are not only much larger and more numerous, but contain irregular deep pockets which are most difficult to reach. In many cases in this war it has been impossible to rescue the wounded promptly, and in many cases wounds have therefore been in a very bad condition before the patient could be cared for.

There are two main ways of treating such wounds: (1) The wounds may be thoroughly cleaned surgically and sewed up at once. Clean wounds usually heal promptly. (2) The second method, which has been given much prominence in the present war, is commonly known as the Carrel-Dakin method. Even wounds already green with pus or ridged with proud flesh have been healed in a remarkably short time by this method. The wound is cleaned surgically as far as the conditions will allow. It is then irrigated by a weak hypochlorite solution, specially prepared to insure a known strength, and to make it less irritating to the tissues. This material is kept in a flask at the head of the bed. From this flask runs a rubber tube one-quarter to one-half inch in diameter with several branches and sub-branches, often as many as twelve or sixteen. An end runs into each little recess or pocket of the wound, and a small amount slowly washes the tissues. At intervals—every two hours, commonly—the pinch-cock or regulator is opened and a generous amount of liquid runs out of each tip into the wound, flushing it With this treatment the bacteria are lessened rapidly; how rapidly is shown by a little material from the wound which is put upon a slide, stained for bacteria, and examined with a microscope. When the bacteria on the slide average but one to five in each view through the microscope, it has been found safe to sew up the wound. Wonderful results have been secured by this method; indescribably infected wounds have been cleaned and made ready to sew up in four to nine days. In ordinary wounds the Carrel-

Dakin treatment is not necessary for more than two to five days, usually. Some months ago Doctor Carrel reported that but one wound so treated and examined had failed to heal properly.

The organisms which have caused most of the wound difficulties in the present war are the tetanus bacillus and the gas bacillus

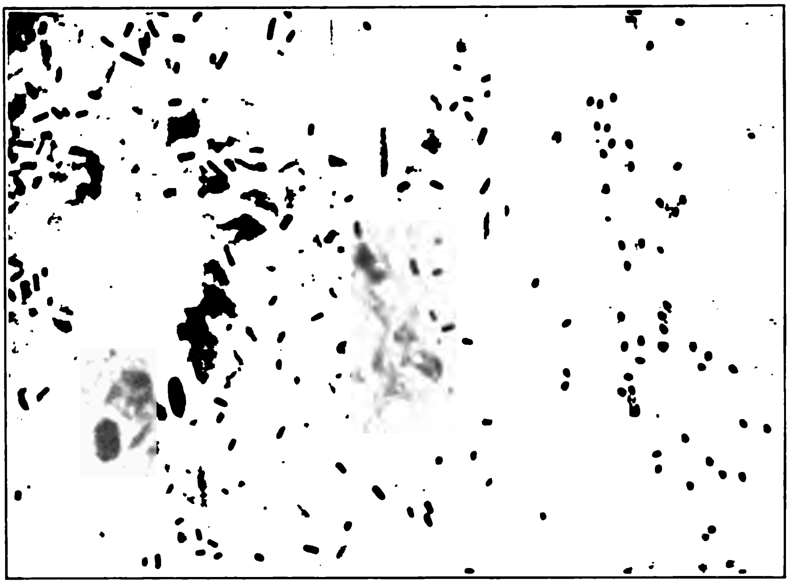

FIG. 102.—Gas bacillus; spores on the right.

(Fig. 102). They are both found in the intestines of man, cow, horse, etc., and may form spores, living a long time in manure-polluted soils. The highly cultivated soil of central Europe contains many of the organisms; wounds are easily infected with soil, especially in the present methods of warfare (explosive shells which break in or near the ground, etc.).

Tetanus or lockjaw is prevented from developing in such wounds by injecting all probably infected wounds with tetanus antitoxin (see p. 207). Lockjaw is now under control, owing in great part to the large amount of high-grade tetanus antitoxin supplied by the United States.

The gas bacillus [8] is harder to deal with, but recently Bull has developed an antitoxin for this gas bacillus; it is now being tried out on the western front, and a large number of horses in England and the United States are already producing antitoxin to use against the gas bacillus. The gangrenous condition which often develops has led to the name "gas-gangrene bacillus." Work on the western front indicates that the horses which are already producing tetanus antitoxin produce a stronger gas bacillus antitoxin than other horses (see table, p. 211).

Navy Conditions.—In the navy the conditions are very different. The air space accorded is considerably less than the minimum requirement (see p. 144). It is often as low as seventy-two cubic feet with twelve square feet of floor space! The excess of moisture—due to the frequent washing of decks and floors, the "bilge" water often leaking in through seams, and the large amount of perspiration of the sailors crowded in such close quarters tend to make the air very oppressive. Ventilating systems designed to overcome this consist of huge pipe systems with fans, exhausts, etc., which draw or force air through the pipe systems. Sometimes these pipes protrude above the deck and face in such a way that the wind or the movement of the vessel helps force air down into the lower levels; often the iron masts are used as ventilating flues. Portholes help somewhat on the upper levels, but only in clear weather, of course. With such rapidly replaced air the drafts may be disagreeable, and too often the ventilators are closed. Tuberculosis and other respiratory diseases are higher among sailors than in the army. The confined sleeping quarters may be responsible. The short sleep periods —broken by watches—may be a real benefit, especially now with the close quarters common in hot steel ships.

The bedding is aired when weather permits, but this is, of course, an inadequate compensation for the other conditions. The beds (bunks, or hammocks) are usually too close together. The hammocks are less easily cared for and less comfortable, the body being always bent in a curve.

The navy ration is lower than the army ration, owing to the

[8] The gas bacillus causes a rapid and progressive infection of the tissues; the accumulation of gas gives the flesh a papery or even crackly feeling under pressure, hence its name. It has, of course, nothing to do with the poisonous gas (gas clouds, gas shells) used at present in warfare.

less heavy exercise (when compared with the soldier's marching with a fifty-five-pound equipment). It is, like our army ration, more generous than that of the other nations. The ration is very elastic, but is perforce limited in range, *e.g.*, canned rather than fresh vegetables. Circumstances affect the food (*e.g.*, amount, meal hours) of sailors less than soldiers, as their food is always in the same boat; and cooking arrangements are more stable and constant. Water is always available for distilling; and the disposal of garbage and human waste is no problem at all, with the whole ocean as a sewer.

PROBLEMS

1. What procedures in military hygiene might well be carried over into civil society?
2. In what health policies or sanitation measures should cities co-operate with nearby military camps?

See Reference List at end of Appendix.

CHAPTER XXIII

RURAL AND URBAN CONDITIONS

FORMERLY all comparisons of city and rural conditions were strongly in favor of the country. In Ogden's "Rural Hygiene," he says:

> It is commonly supposed that good health is the invariable accompaniment of country life; that children who are brought up in the country are always rosy-cheeked, chubby, and, except for occasional colds, free from disease; that adults, both men and women, are strong to labor, like the oxen of the Psalmist, and that grandfathers and grandmothers are so common and so able-bodied that in practically every farmhouse the daily chores are assigned to these aged exponents of strong constitutions and healthy lives. If, however, we are honest in our observations, or have lived on a farm in our younger days, or have kept our eyes open when visiting in the country, we will remember, one by one, certain facts which will persistently suggest that, after all, life on the farm may not be such a spring of health as we have been led to believe. We will remember the frequency of funerals, especially in the winter, and the few families in which all the children have reached maturity. We will remember the worn-out bodies of men and women, bent and aged while yet in middle life.

We have most of us heard disquieting rumors regarding the higher death rates of country babies as well as adults; the preventable defects are greater among country than among city children; and one almost hesitates to visit the country, so widely have "vacation typhoid" and similar dangers been denounced.

What is the real situation? First of all we must admit that the usual idea of country conditions is based more upon general impression than upon actual figures. The registration of deaths and undertakers' permits are more incomplete there than in the city; often there are no records at all of illnesses, even communicable ones.

Mortality Figures Compared.—What figures we have indicate that there has been a change in the health conditions. Up to 1900 (Fig. 103) the death rate in rural New York was less than in New York City, but now it is safer to live in the largest city in the United States than in the country surrounding it. Biggs, Health Commissioner of New York State, says for that State that "the

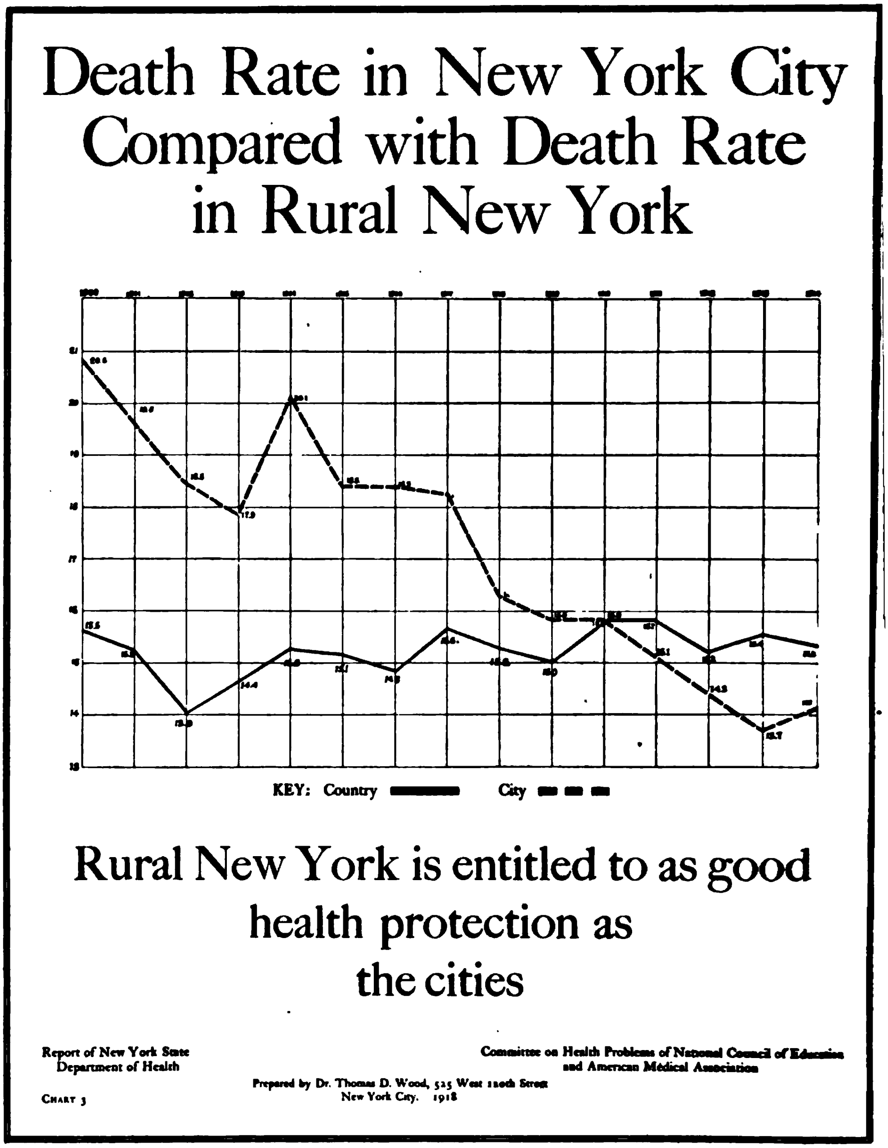

FIG. 103.—What the city has done the country should do.

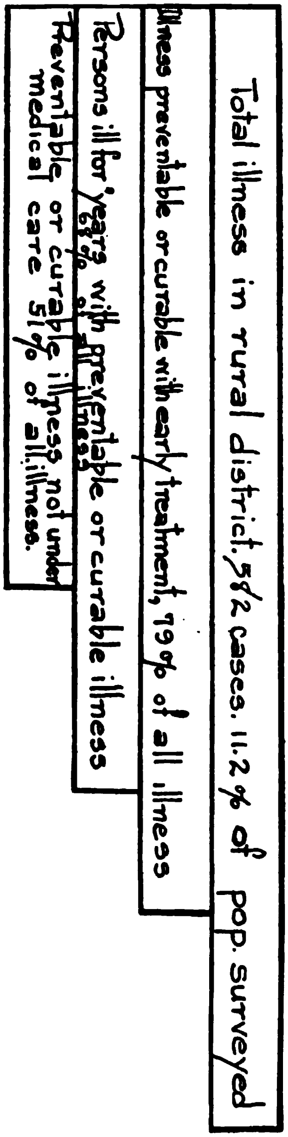

FIG. 104.—The investigations in Albany County, New York, indicate that curable defects may go untreated throughout life. (Health News, New York.)

rural death rate from general diseases, typhoid fever, malaria, diarrhœa, and enteritis, is greatly in excess of that in urban districts." See also Fig. 104 for preventable disease conditions. In the "registration area"[1] of the United States, however, the death rate for 1912 is about the same for city and country—14 per 1000 in the cities, and 12 per 1000 in the rural regions of the States. If the areas not in this census were included, the balance would probably be as in New York State, for regions so lax as not to be represented in the registration area have probably very low standards of health and sanitation.

The death rate for children under one month is higher in the country; after that it is higher for city children. But the consideration of real importance is health, not deaths, of course, and the health defects and diseases are much greater among country children than among city children (Fig. 105).

Physical Defects.—The newspapers during the examination of drafted men for our army have given alarming figures concerning the relative fitness of rural and urban men. A more recent comparison by Provost Marshal General Crowder based on about 80,000 men examined from city and rural localities having no large immigrant element in ten widely separated States (*e.g.*, Alabama, California, Kansas, New York) shows that the conditions in men of draft age are really much the same. The urban areas rejected for physical reasons 28.47 per cent. of the 35,000 men examined; the rural areas, 27.96 per cent. of the 44,000 men examined.

The figures indicate rather that both rural and urban conditions need our serious attention, if nearly three out of ten men in the prime of life are exempted because of physical disability. Of these defects many are preventable: 21 per cent. of the rejections were due to defective eyesight, and over 8 per cent. to defective teeth.

Predisposing Factors.—What is there that can account for the shifting balance in favor of city life?

Homes.—First, there are in the country many predisposing factors toward disease, all of which are mentioned under other headings in this book. They include poorly protected wells and springs

[1] The registration area included here represented but twenty-three other States. It now includes twenty-six States and parts of thirteen other States (see Glossary, also).

(*e.g.,* with uncovered or with leaky covers, receiving surface drainage); unsanitary privies (*e.g.,* unscreened, opening into brooks, etc.); poorly-lighted and poorly ventilated houses and cellars; too meagre a supply of water; lack of facilities for washing of hands and bathing; and too monotonous a diet. Each of these points could be enlarged upon with profit. For example, Andress states that 75 per cent. of the country dietaries examined were deficient in milk, eggs, butter, vegetables and meat; in fact, deficient in the very products raised in those localities!

That the other conditions are due to ignorance rather than poverty is shown by the large number of really substantial rural houses which have dark, water-holding cellars, dark rooms, and inadequate ventilation. Superstitions last longer in the more conservative country districts, and adequate night ventilation is not common. A sanitary investigation of four whole counties in Indiana showed very poor conditions throughout the entire area. Andress states that "the county having the highest average score, had these individual scores on the ten points considered: (1) site, 73 per cent.; (2) sanitary condition of premises, 68 per cent.; (3) house, 68 per cent.; (4) cellar, 31 per cent.; (5) ventilation, 14 per cent.; (6) water supply, 15 per cent.; (7) sewerage disposal, 32 per cent.; (8) barnyard, 55 per cent.; (9) disposal of manure, 22 per cent.; (10) health, 29 per cent.

School Conditions.—Rural schools are also very far below the standards which healthy living demands. In this same State a census of seventy-five rural schools yields the following facts:

0 had fire apparatus of any kind.

4 per cent. only had sanitary drinking fountains.

75 per cent. used a common wash basin.

9 per cent. only had adjustable desks.

14 per cent. only of the boys (41 per cent. of the girls) used tooth brush daily.

75 per cent. had a questionable water supply (shallow wells, etc.).

In some localities the conditions are still worse. In the South, for example, Stiles has estimated that 68 per cent. of the rural schoolhouses have no privies whatever (the widely contaminated soil aiding greatly in the direct transfer of hookworm (Fig. 44) through

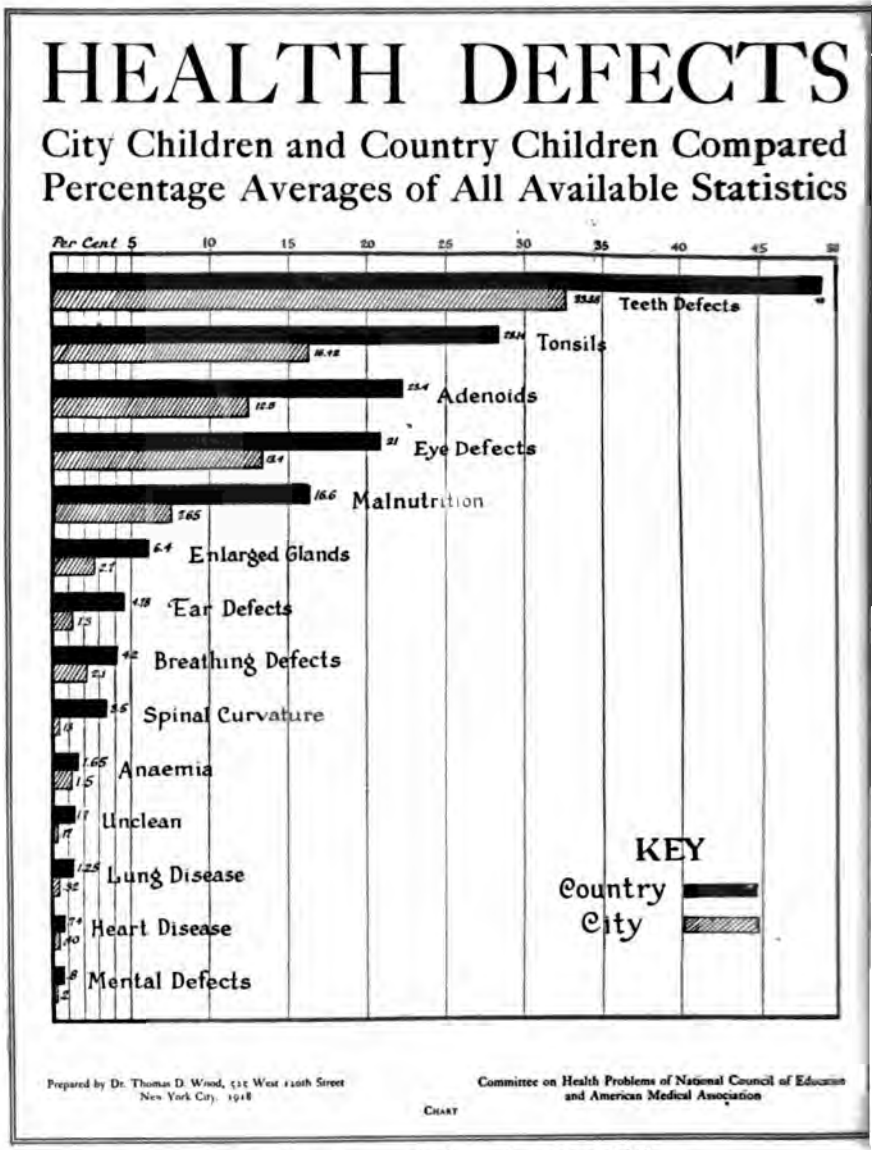

Fig. 105.—Is your school record as poor as this?

NATIONAL WELFARE AND RURAL SCHOOLS

Country children are less healthy than city children

City standards of living are more healthful than those in rural regions

National welfare depends upon the health of the people

National preparedness depends primarily upon biologic fitness and physical efficiency

Country children deserve as much health and happiness as city children

Country children are entitled to as careful cultivation as crops and live stock

The rural school is the way to improvement of health of country children and of rural life

Prepared by Dr. Thomas D. Wood, 525 West 120th Street
New York City. 1918

Committee on Health Problems of National Council of Education
and American Medical Association

CHART 34

FIG. 106.—Can you think of some way of driving these facts home?

described first by our forefathers among our inalienable rights—for life without health means neither liberty nor the pursuit of happiness. It is to be hoped that the federal government will find some way to secure to the scattered rural population fuller opportunity for healthful living.

PROBLEMS

1. Military leaders say that city-bred boys are more easily trained, less susceptible to communicable diseases (*e.g.*, measles), and of higher technical value in war; after the first year or two of training, country-bred boys are found to be better soldier material. Can you explain this?

2. The "old oaken bucket" is used in open wells, subject, Brewer says, to all the filth that blows, rolls, or falls. What other picturesque associations of rural life must go?

3. Fill out the other two columns for the topics listed below, showing the advantages and disadvantages of city and rural life with regard to each. How many vary with the housekeeper or the individual rather than the locality itself?

City		Country
	fresh air	
	sunshine	
	simple foods	
	monotonous diet	
	hours of sleep	
	exposure to weather	
	lack of (mental or social recreation)	
	poor ventilation	
	medical care	
	poor drinking water	
	transfer of communicable diseases	

4. What can rural districts do with the materials at hand to attract better teachers? What can they do to offset city salaries, *e.g.*, building little log bungalows for teachers' homes, providing horses or vehicles for recreation?

5. Can your rural district organize a traveling clinic for teeth, eyes, baby care, or whatever is most needed for your community and adjoining ones? Eighteen hundred dollars a year would doubtless secure a young dentist or physician; if six communities joined together this would mean but $300 a year for each community. Would it be worth $6 a week to your community? A small fee could be collected from each patient, if advisable.

6. How might the handkerchief be used more effectively in reducing disease transfer? Show that visible dirt is not the sole criterion for discarding a handkerchief.

7. Secure from the nearest large city, such as New York or Chicago, a set of the regulations concerning examinations and licenses for eating houses, food handlers, slaughter houses, and stores or markets. How many can you put into operation in your own community?

8. When a farm family moves into the city what new conditions do they find which aid in health protection? To what conditions must a city family give special thought or care if they "go back to the land"?

See Reference List at end of Appendix.

CHAPTER XXIV

VITAL STATISTICS

IN any well-organized community each resident usually appears several times by name in its public records. This statement does not refer to the various military, political, or other civil records necessary to govern the country and to insure to each inhabitant his property and other civil rights. People not holding office, not owning property, and not having the privilege of voting do not appear in the latter records; but they, as well as all other residents, do appear in what may be termed the *vital* records—the records of births, deaths, etc.

Each person is quite sure of appearing twice in such records—once in the registry of births and once in the death records (death certificates, burial permits). All who reach maturity may appear also in several other public records: the population records, popularly termed "the census," the reports of communicable diseases, and the marriage records.

General Value of Vital Statistics.—The above records are valuable in several ways; for example, the birth registrations may be used to establish a child's parentage, a man's voting age, or one's rights to property. These records have distinct hygienic value also: First, as indications of the nation's strength as shown, for example, by a low morbidity (illness and disease) rate, by deferred death ages, and by a normal increase in legitimate births when accompanied by low infant mortality rate. See also in this connection Fig. 107. Second, they are valuable as indications of what the community should do to improve the nation's strength, and largest asset, the health of its people. This is evident when such records are worked over,[1] and sorted according to significant details, such as the num-

[1] In some cities where elaborate records are kept, the cards are punched in appropriate places to record the dates, the name of the disease, the sex of the individual, etc. These may be sorted rapidly by machinery, the sorting machine being set to catch a given perforation in the passing cards. In that way, for example, all the ages under 5 may be quickly sorted out; the machine can then be reset to sort out all of these children dying of a given disease, or all not vaccinated, etc.

ber dying from a given preventable disease, or from a dangerous occupation. In such summarized records, the individual does not appear by name—simply as one of the group under consideration.

Methods of Presenting.—When such records are worked over for publication or comparison, it is usual to report the results in percentages or in proportion to a given unit of population; the common units are a thousand and ten thousand, though one hundred thousand is not uncommon. If the percentages in each group are large throughout, the familiar per cent. basis may be used; "30

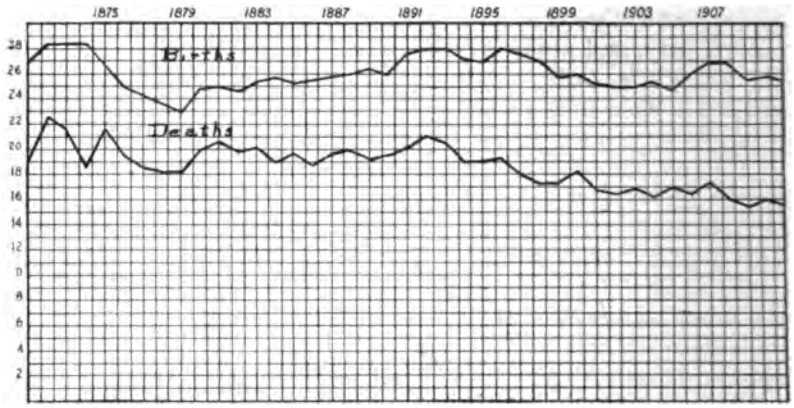

FIG. 107.—Birth and death curves for Massachusetts from 1871 to 1911. Is there any period where the relation of births and deaths as given (per 1000) would mean a decrease in population?

per cent. of the children are anæmic," for example. But if the ratios are low, but a part of a per cent., it is better to use the larger unit of 1000, 10,000, or 100,000; thus an industrial death rate of .01 per cent., or one-hundredth of 1 per cent. means but part of an dividual and so means nothing at all to most people. But expressed in the 10,000 unit, .01 per cent. becomes one person in every 10,000, a whole real man, for example, who might still be alive if a safety brake had been in use.

In popular articles, the conditions are often made still more graphic. A typhoid rate of thirteen per thousand for a given city of 80,000 is not nearly so alarming as is the total, 1040 per year, or 20 *every* week.

Careless or prejudiced workers sometimes justify the joking

classification of statistics as the third and worst class of lies; *e.g.*, small groups may be given equal rank with larger groups,[2] and the result may be unduly alarming or falsely reassuring. On the whole, however, the reports issued by boards of health and other investigators are worthy of the people's trust.

All statistics are not based on total population units. A large mining camp containing but two or three children might be credited with a low infant mortality, even though all of its children died, if their deaths were compared with total population. It is fairer—more indicative of the actual conditions—to compare such actual deaths with the possible deaths; and we therefore base infant mortality rates for a given year on the infants born that year.

Similarly, changes in the total population depend not only on the difference between the birth and death rates, but upon the migration of large masses of adults, *e.g.*, laborers, military bodies. In the same way comparisons of the birth rates in various States are not fair, unless the basis of comparison includes the number of married women, and also the women of child-bearing age. Cancer statistics should be based on the number of cancer age (p. 301), not on the population.

Collection of Vital Statistics.—Vital statistics are collected in two main ways: (1) singly, as the events occur (births, marriages, deaths); or (2) by an organized enumeration or census. The latter may be taken as our recent registration of men of military age was conducted—by having all the individuals report to assigned stations within a given period. Lists of eligible voters are usually made up in that way. The national census and city or State censuses are made by a house-to-house canvass. Each method has its own difficulties, and wholly accurate records are probably not attainable in either way in any country not overofficialed.

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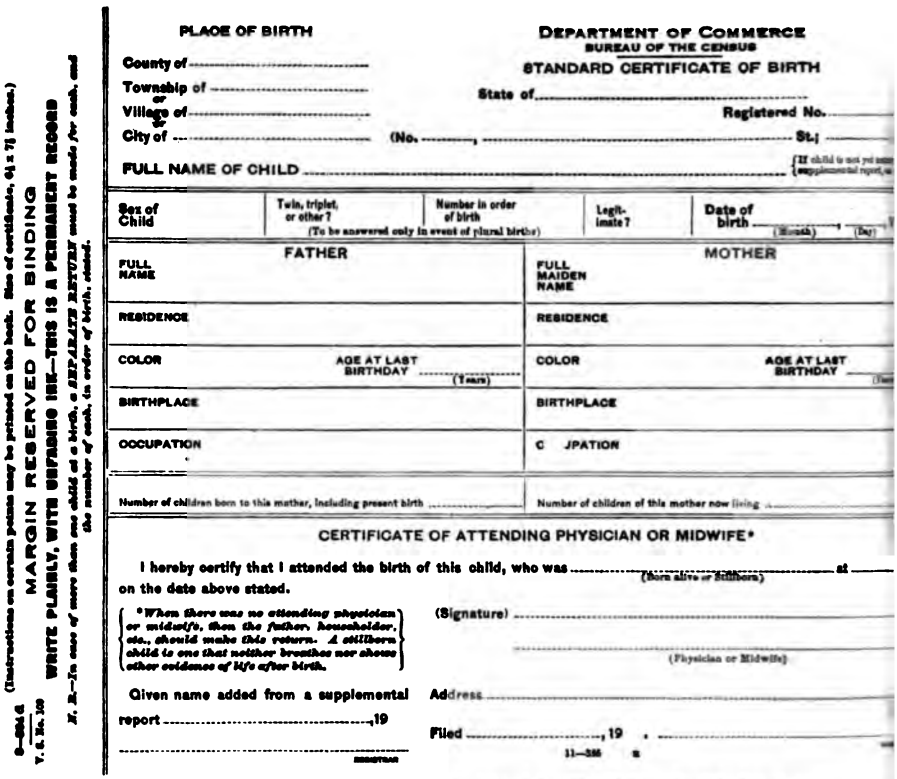
[2] To illustrate. For three adjoining localities the death rate for typhoid was as follows: 1 in 15, 25 in 453, and 76 in 52,427 total deaths. For the whole region one result would be obtained by adding all the results, giving a total of 102 typhoid deaths in a grand total of 52,895 deaths, or a typhoid rate of 19 per 1000. Another result would be obtained by considering the various ratios; in the first it is 1.15, or 66 per 1000; in the second, about 1.18, or 55 per 1000; and in the third, about 1.689, or 1.4 per 1000. If we consider these ratios as equally important, we have a death rate of 122.4 per 3000, or 40.8 per 1000 instead of 19 per thousand obtained by the other method.

Details Included.—Many different details are included in most of these statistical records (Figs. 108 and 109), especially in the more advanced States. The population census, for example, includes about twenty-five details, such as age, sex, color or race, married or single, number of children, nationality of parents, native, natural-


PLACE OF BIRTH
County of
Township of
or
Village of
or
City of (No. St.;
DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
STANDARD CERTIFICATE OF BIRTH
State of
Registered No.
FULL NAME OF CHILD

Sex of Child	Twin, triplet, or other?	Number in order of birth	Legitimate?	Date of birth (Month) (Day)
	(To be answered only in event of plural births)			

FATHER	MOTHER
FULL NAME	FULL MAIDEN NAME
RESIDENCE	RESIDENCE
COLOR AGE AT LAST BIRTHDAY (Years)	COLOR AGE AT LAST BIRTHDAY
BIRTHPLACE	BIRTHPLACE
OCCUPATION	OCCUPATION
Number of children born to this mother, including present birth	Number of children of this mother now living

CERTIFICATE OF ATTENDING PHYSICIAN OR MIDWIFE*

I hereby certify that I attended the birth of this child, who was (Born alive or Stillborn) at on the date above stated.

*When there was no attending physician or midwife, then the father, householder, etc., should make this return. A stillborn child is one that neither breathes nor shows other evidence of life after birth.

(Signature)
(Physician or Midwife)

Given name added from a supplemental report ,19

Address
Filed ,19

MARGIN RESERVED FOR BINDING
WRITE PLAINLY, WITH UNFADING INK—THIS IS A PERMANENT RECORD

FIG. 108.—Standard birth certificate issued by the Public Health Service.

ized or alien, occupation, ability to read and write, and ownership of property, including also certain physical defects (*e.g.*, blindness).

Errors.—Errors in such records are to be expected. Misstatements concerning age make a large proportion of these: often the date of birth is not known; old people grow old more rapidly than

the passing of time warrants; many people forget their ages; and records always show an excessive number of people at certain standard ages (*e.g.*, forty, sixty-five). Occupation is another uncertain item, mainly because the descriptive terms for work do not include all the present manifold forms of labor; *e.g.*, manager may mean either a desk or an outdoor position. Conclusions as to occupational predisposition to disease would be affected by such broad or vague terms. The mortality rates for certain occupations are not to be fairly estimated by such records: someone has illustrated this by showing that newsboys have a very low mortality rate when compared with bank presidents, not because the newsboy business is a very safe or protected one, but because newsboys are young and bank presidents are old, because they are selected from the older experienced men.

The very human tendency to procrastinate is responsible for other errors, especially in birth registrations.[3] In certain cases such lack of responsibility may be partly neutralized by preliminary permits; *e.g.*, a marriage license is usually required before the marriage ceremony can be performed, a death certificate must usually be presented to secure a burial permit, without which the body cannot be buried, removed to another place, etc. Such measures prevent deception, and help to detect and keep down crime. While there are in some States fines or other penalties for delaying or omitting registrations, carelessness in such matters is rarely penalized except in the case of deaths. The United States authorities consider the death reports for the registration area of the country at least 90 per cent. correct. The full co-operation of the States has not been obtained as yet; the reliable or "registration area" includes but twenty-six States and parts of thirteen others. The importance of such records should be emphasized by civic and State authorities in such a way that the co-operation of the people can be secured.

There are probably yet untried ways of securing more complete records. Colored cards might be provided by each city, county, etc.,

[3] In some other countries the prompt recording of such statistical reports is enforced much more severely. An American family who happened to be in Germany when a daughter was born, delayed for a few days the prescribed regulations, because the family could not decide upon a name. The father was forcibly taken to court and detained there until he decided upon a name.

a different color for each type of record (*e.g.*, births, notifiable diseases). These might be left in specially provided racks in all public places (churches, schools, police offices, post offices, etc.), and in common carriers (railroad trains, street cars), and halls of apartment houses, and large commercial offices. Individuals knowing of a suspicious death, an as yet unquarantined house, or an unregistered birth could fill in one of these addressed cards and mail (without postage). If protection were assured the sender, and attention paid to only fully signed cards (with sender's address, occupation, etc.), this might prove a good system of checking up on the reports sent in, and insuring greater accuracy and completeness.

There is still another class of mistakes which are probably unavoidable, but which limit the hygienic importance of such records. The causes of death are often incorrectly stated, sometimes for illegal reasons or to hide crime, but more often because of the difficulties of diagnosis experienced by even good physicians. Even in hospitals (where the opportunities for correct diagnosis are usually good) many errors appear, and autopsies show that in one set of over three thousand patients there were many incorrect reports; liver and kidney diseases, for example, could boast but 16 to 39 per cent. of accurate reports, though many other diseases were, of course, well reported (*e.g.*, typhoid, 92 per cent. correct). It is often difficult to give one definite cause of death; to meet this difficulty certain rules are established to guide when there is a "complication of diseases." The preference is given to the frequent over the infrequent, to the one most often fatal, to the primary disease, etc.

Community Rights.—The value of morbidity statistics (this includes death (mortality) and also illness) has not been widely recognized as yet. It is just as important for a country to know the per cent. of effective people as it is to know the per cent. of people not yet actually dead.

Each day of illness is an economic loss to any productive citizen, and may also affect his general vitality sufficiently to lessen his expectation of life. Then, too, communicable diseases, if not reported, may spread rapidly and become directly a community problem (see p. 310).

Other Values of Vital Statistics.—As "municipal bookkeeping" vital statistics are most important. There is no clearer way of showing a community just where it stands. In a period of about

ten years Jersey City's typhoid death rate fell from 61 per 100,000 to 19; in the same period Pittsburgh's rose from 61 to 120! Could anything justify more fully Jersey City's expenditure of money in treating the river water it was using for drinking purposes, and could anything make it clearer to Pittsburgh that such expenditure was necessary?

Occupational diseases are reportable in but seven to fourteen States, more or less completely. In the last draft over 60 per cent.

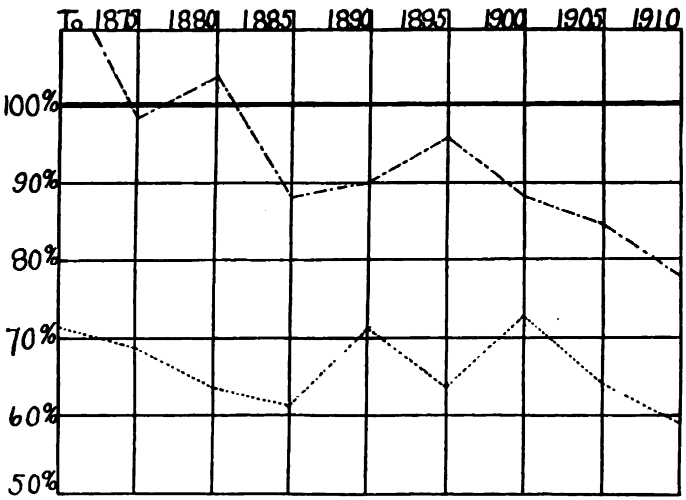


FIG. 110.—The heavy line near the top (100 per cent.) represents the expected mortality; the line beginning in the upper left-hand square gives the ratio of deaths among non-abstainers from alcohol; the lower line shows the ratio of deaths among abstainers.

of the *factory* youth, according to the head of a large industrial union, failed to pass the physical examinations. The large number of still-births among women employed in industrial occupations also illustrates the hitherto unguessed-at relation between health and occupation, and shows clearly the community's responsibility.

More general interest in vital statistics would increase the "registration area." Still more would it help secure *complete* records of all required data in the registration area. "Too great individualism" explains part of this lack; but part of it is tied up with what is commonly termed physician's honor. There is the greatest reason

in the world for respecting the general principle which demands that physicians keep inviolate knowledge that would be to the disadvantage of his patient. But the individual rights must not conflict with the good of the community to such an extent that he can become a focus of infection. This reticence is felt particularly with regard to venereal diseases. Common sense says that there is little excuse for the type of reticence that makes a physician side with a client when speech would protect ignorant members of the household, or prevent the birth of children who can have but little chance of health and sanity. There is little doubt that physicians generally will be greatly relieved to have public opinion demand the complete and full recording of *all* communicable diseases. And that it is for the good of the community no one can deny.

The value of such statistics has been recognized by various commercial organizations, and tables showing the expectation of life, and how it is affected by various physical characteristics and disabilities, by occupation and by such habits as alcohol and smoking. are the basis of their insurance and annuity rates (Fig. 110). If they have proven important to those who make money on the prolongation of our lives, why are such records not sufficiently important to us to help us see how we can still further prolong a useful life period? Can we as a country or as individuals afford to neglect the securing of complete vital records, and their presentation in usable form?

PROBLEMS

1. What vital statistics are compulsory in your State?
2. What items of value are not included in the birth certificate used in your locality? In the death certificate?
3. Give reasons or instances justifying each of the various items in the birth certificate used in your locality. In the death certificate. In the marriage license.
4. Do the life insurance rates vary with state of health? alcoholic habits? or with age only? If the rates are the same, who really pays the extra premium for people who are poor risks?
5. What physical defects are most common in the students of your school? What per cent. of these are preventable? Has your State any provision for remedying these conditions?
6. Show that the recent ruling adopted for the State of New Jersey allowing districts to spend public money for school conveyances for crippled children is a legitimate expenditure of money.
7. What is the most common cause of death in your community? Can this be explained? What per cent. of deaths in your town are due to contagious diseases?

8. Make birth and death curves for your town for the last five years. How does this agree with the population curve? Explain the likenesses or differences.

9. The following is from a pamphlet issued by the New Jersey State Board of Health. How does your State stimulate interest in vital statistics?

IS YOUR BABY REGISTERED?
IF NOT, WHY NOT? ASK YOUR PHYSICIAN

Your baby will need a birth record

To prove his right to go to school.
To prove his right to working papers.
To prove his right to an inheritance.
To prove his right to vote.
To prove his right to marry.
To prove his right to a passport when travelling abroad.
To secure protection in foreign countries.
To prove his mother's right to a widow's pension.

Prize cattle are registered. If your baby is a prize baby, register him; if not, be sure to register him and ask your physician and the health authorities how to make him a prize baby. Do it now.

10. Fill in the blanks in the following

..................statistics are the statistics of life.
Morbidity statistics are the..................of disease.
..................statistics are the statistics of death.
Birth, ... and migration statistics relate to population movement.
Statistics of .... and of immigration show population increment.
Statistics of .... and of emigration show population decrement.

See Reference List at end of Appendix.

CHAPTER XXV

HEALTH EDUCATION

Early Movements for Health Education.—One of the first, if not the first, altruistic movements for health education in the United States was Horace Mann's endeavor to introduce the study of the human physiology into the public schools. This appeal was not made until in 1842, so slow were we to realize that health, the one great asset of any nation, demands as well as deserves conscious consideration.

The first nation-wide movement related to health was the campaign against tuberculosis. Infant welfare was the next definite campaign against disease, and both have accomplished marked results. In regard to both these causes—tuberculosis and infant welfare—it is well to remember two things: (1) That they have been definite campaigns with definite ends in view, and (2) that while remarkable results have been attained in the lives actually saved, the greatest value to us as a nation lies elsewhere—in demonstrating that mere curing is too slow a method of combating the evils under discussion, that better results are obtained by prevention, that conscious and intelligent care can prevent not only death but illness, and that predisposing factors can be controlled.

Need for Health Education.—How, then, is this movement to be made a *general* movement? How can the principles of hygiene be made concrete enough to appeal to all the people? For they must be so concrete that they appeal to all—even to the stranger within our gates; they must be so clear that even the wayfaring man may not err therein.

Every chapter in this book is a plea for health education. The standards set forth and the evils to be avoided call for definite knowledge on the part of each individual, for expensive and sweeping innovations are demanded which must be supported by public sentiment. Besides, many of the necessary changes or desirable procedures are so individual that only by securing individual responsibility and action can we secure the desired result (Fig. 111).

Without education concerning health, we can do very little.

INDICATIONS of HEALTH DISORDERS in CHILDREN

For which parents should keep children at home and notify the school

Nausea or vomiting	Fever
Chill, convulsions (fits)	Acutely swollen glands
Eruption (rash) of any kind	Cough
Red or running eyes	Running nose
Sore or inflamed throat	Failure to eat the usual breakfast

Dizziness, faintness or unusual pallor (alarming paleness of the face)

Any disturbing change from usual appearance or conduct of child

The foregoing signs should be used also by teachers as a basis for excluding pupils from school for the day, or until signs have disappeared, or until the proper health officer has authorized the return of the pupil to school

Prepared by Dr. Thomas D. Wood, 525 West 120th Street
New York City. 1918

Committee on Health Problems of National Council of Education
and American Medical Association

CHART 4

FIG. 111.—This demands a strong sense of community responsibility as well as consideration for one's own children.

We may provide free cancer hospitals, but they are of little use unless people realize that *early* treatment is necessary; milk stations probably save about one-fifth of our babies, but intelligent home care is needed to insure the welfare of the other four-fifths. We may frame model housing laws, but we can't legislate that a family in those houses shall eat the proper foods or sleep with open windows. Health education is necessary also in order to secure the proper support for the necessary legislation and taxation. Health officers, school nurses, improved water supplies, proper methods of sewage disposal, the enforcement of quarantine, the free diagnosis of communicable disease cost money, and public approval of such expenditures is usually necessary. This necessity for the support by the taxpayers and voters is felt most directly in small communities; in large cities as well as in smaller communities it often acts as a curb on political machines who would prefer to deflect the money into other channels.

Present Educational Systems Inadequate.—Since the movement is fundamentally one of education, the schools naturally come into our minds. As Evans has stated, the public schools are too slow. We must wait a generation, if we depend wholly upon them. Quicker results would be obtained through our higher schools and colleges. Does it not seem unwise to give the care of our children for a good part of the day to teachers who know nothing of human physiology? Yet many of our normal schools give no instruction in physiology or hygiene; in many other normal schools they are not considered sufficiently important to be classed as separate subjects, but are given a few hours' time in connection with gymnastics or nature study! Colleges, too, forget that "the proper study of mankind is man," and some of our largest and best known colleges do not require human physiology, hygiene, or bacteriology. In some of them such courses are not even offered. Clearly, then, we cannot wait for the schools, though there are encouraging signs that such responsibilities are being realized even by the most conservative.

General Suggestions.—The federal government has under consideration a plan for introducing throughout our public school system better instruction in hygiene. This plan is not yet perfected, but real benefit can safely be expected from this movement. In the meantime we must utilize any cause, interest, or movement that

arises. We must not wait for a star, but must hitch our wagon to any force moving in the right direction.

The present war is a good illustration. How will the millions of soldiers who have been inoculated (G) against typhoid weigh the respective values of prevention and cure? Will those whose lives depend on the sanitary provisions carried out effectively under difficulties in trench life feel that ordinary localities cannot be kept in a sanitary condition? Will they view in the same careless way, as formerly, the requirements regarding quarantine and disinfection? Every home, every street, as safe as the trenches is not asking too much. The emphasis on age limits in the present war can be used to emphasize the value of vital statistics and to extend the registration area (G), for such statistics as birth records are as necessary for the patriotic youth seeking to enlist as for a government that needs to compel the service of "slackers."

Every locality will have its own special interests—temporary or permanent—which can be utilized for advancing health education. Civic pride, competitive spirit, can be used as a lever. Every Tacoma has a Seattle, probably, and what better totem pole than a tree of life? Civic pride could be used to help maintain many a "spotless town." The school often makes an appeal to more people than any other one community interest. The aims set forth in figures 112 and 113 can be taken up singly, if advisable.

More or less transitory interests can be utilized to further the opportunities for health education. These interests may be most varied in range: a mosquito summer, food poisoning (G) after a grange supper, an infantile paralysis epidemic, or a political campaign. Whatever the interest that vitalizes the movement, the campaign should be conducted vigorously, and be brought in style to its proper conclusion. The workers or originators should have definitely in mind the aim of the movement: *e.g.*, forming public sentiment or securing new health legislation. Such campaigns will often take more strategic planning than political campaigns, for there are relatively few people interested both unselfishly and directly in improved health conditions.

Attention should also be paid to the permanency of the reform. All movements for the public good should be established "with perpetual care." If bills are passed they should carry an annual appropriation to make their execution possible. If ideals or stand-

Ten Sanitary Commandments for Rural Schools

In every school which may be considered passably sanitary the following conditions shall obtain:

1. Heating by at least a properly jacketed stove. (No unjacketed stove to be allowed.) Avoid overheating. Temperature should never go above 68F. There should be a thermometer in every schoolroom. Ventilation by open windows when weather permits and by opening of windows at frequent intervals even in winter

2. Lighting from left side of room (or from left and rear) through window space at least one-fifth of floor space in area

3. Cleanliness of school as good as in the home of a careful housekeeper

4. Furniture sanitary in kind and easily and frequently cleaned. Seats and desks adjustable and hygienic in type

5. Drinking water from a pure source provided by a sanitary drinking fountain

6. Facilities for washing hands, and individual towels

7. Toilets and privies sanitary in type and in care (with no cesspools unless water tight) and no neglected privy boxes or vaults

8. Flies and mosquitoes excluded by thorough screening of schoolhouse and toilets

9. Obscene and defacing marks absolutely absent from schoolhouse and privies

10. Playground of adequate size for every rural school

Prepared by Dr. Thomas D. Wood, 525 West 120th Street
New York City 1918

Committee on Health Problems of National Council of Education
and American Medical Association

Chart 38

FIG. 112.—Minimum standards for rural schools.

Ten Essentials for Health Care of Children in Rural Schools

1. Daily health inspection by parent and teacher with the co-operation of school nurses and doctors

2. General health examination including dental examination at least once a year

3. Follow up health work with provision of medical, surgical and dental care for correction of health defects, with service of school or district nurse, to make effective the health program in the school

4. Warm school lunches for all rural school children

5. Sanitary and attractive school houses and surroundings

6. Efficiently trained teachers who are qualified to do their full share in the care of health and welfare of the children

7. Practical health instruction of all pupils for the establishment of health habits and the extension of health conduct and care to the school, to the homes and to the community in general

8. Special classes and schools for the physically and mentally defective

9. Generous provision for wholesome play and recreation in school and community

10. Organization and cooperation of interested people and societies to insure to all the children the essentials of health and general well-being

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New York City 1918

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Chart 49

Fig. 113.—Can your community afford to disregard any one of these essentials?

ards are developed, they should be established by the selection of virile, interested officers or committees.

Extreme statements or unsound arguments must not be used in working up such a campaign. Impossible standards must not be set, for the slump which inevitably follows will be difficult to overcome.

Schools.—Even though we can't wait for children to grow up, the work must be begun and carried on in the schools, for the sake of the next generation. Much spreads directly from the schools to the home, and such campaigns as open-window week, clean-up week, and fly-killing contests have good effects. Junior health officers have been tried with good results in some towns. Their work need not be confined to the school, but could easily include many phases of community health work, such as clean streets, refuse or garbage accumulations, care of stables, flies and rats in shops and markets.

Other Suggestions.—Organizations already in existence may be utilized, such as mothers' clubs, little mothers' clubs, scout organizations, women's clubs, men's mercantile associations, labor organizations, and civic clubs.

Fly campaigns may be utilized. In the latter, care must be taken to avoid encouraging dishonesty. Offering prizes for the largest number of flies collected and killed has led to the breeding of flies. If such campaigns were conducted for but a brief time—ten days or less—the time would be too short to allow such sharp practice to enter in. Wood suggests that fly campaigns be centred upon the breeding places rather than the flies. Still better is the suggestion of "no-fly days," with stores, markets, etc., homes, all working to eliminate flies so completely that July 4th or some other day shall be a no-fly day. Girl or Boy Scouts might be utilized as reporters for such "no-fly days."

Clean-street competition can be participated in by the whole community. Scoring stores has been tried by several cities. The best plan seems to be awarding indicative signs (*e.g.*, for no flies) or certificates to all passing certain minimum standards, such as relate to flies, cleanliness, refuse.

Exhibits.—Exhibits have been a favorite method. They must attract the people they are designed to help. Baby-welfare campaigns must reach the foreigners and slum residents as well as other citizens. The location must be carefully considered; it is some-

times better to move the exhibit to various localities, adapting it to the needs of each locality.

The exhibits must be simple, clear and readable. Too many diagrams confuse most people. The labels should not be too long. The individual parts of the exhibition should be separated, so that interested groups may study at leisure those they find interesting. Contrasts—good and bad; before and after; what to do and what not to do—are most easily interpreted and assimilated. Statistics

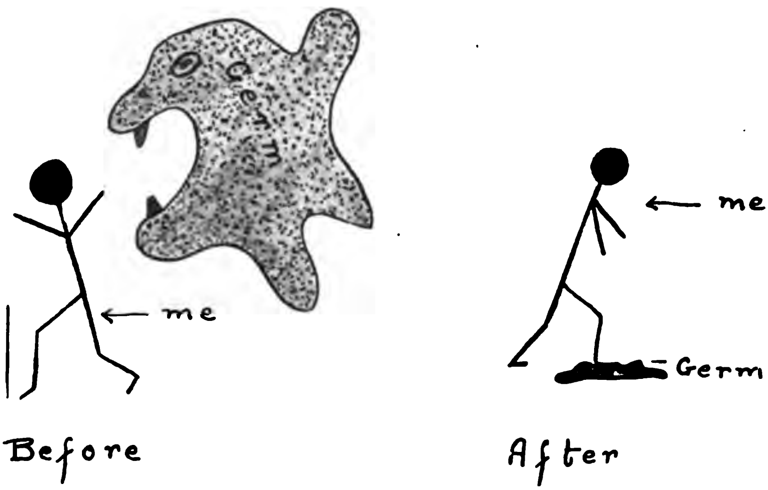


FIG. 114.—What can be done to help people who would rather not know how dirty the milk is, the unclean way in which typhoid is usually transferred, etc.?

must be put vitally; for example, intead of "12½ per cent. of the deaths are due to cancer," use "1 in 8 dies of cancer."

While the evils to be corrected must be made concrete and real, the tone of such exhibits must not be morbid. The impossible must not be set as a standard. The terror realized must be a terror conquered, as shown in the "before and after" illustration (Fig. 114).

The United States Health Service and several of the States have exhibits which may be borrowed by interested communities. Organizations such as the Children's Bureau at Washington and the National Mental Hygiene Society in New York City are very generous with literature. The Child Health Organization, New York

City, is beginning a child-saving campaign, and offers advice, literature, and even local surveys at cost prices. The National Child Welfare Exhibit Committee of New York has good exhibit material. Some State health departments issue each week a series of timely articles, such as "Summer or Vacation Typhoid"; "Flies Our Enemies"; "Water and Typhoid Fever"; and "Vaccination." In 1914 over four hundred local newspapers were using such articles issued by the New York State Department of Health, thus reaching weekly one and a half million readers.

PROBLEMS

1. Show that Lord Derby was right when he said, "Sanitary instruction is even more important than sanitary legislation."

2. Arrange in order most needed in your community the following activities: (1) investigation of the infant mortality rate, (2) of the industrial death rate, (3) the typhoid rate, (4) sanitary quality of milk, (5) erection of a city pasteurizing station, (6) a garbage-disposal plant, (7) subsurface drainage for the school, library, church, etc., (8) filter or storage reservoirs for water, (9) fly-screens for the schoolhouse, and (10) care of the streets.

3. If an organization in your town had $500 (or $25) to spend for public health, what would be the wisest expenditure of that money?

4. Show that it might be wiser to spend it all on a sanitary survey to portray to the people the real condition of affairs, and trust to securing from them when awakened the money necessary to correct present evils.

5. What books (or important pamphlets) on public and personal health are in your public library (or school library)?

6. The Carnegie Corporation is now starting a survey of the Americanization of our foreign population, including schooling of the immigrant, adjustment of home and family life, care of health, naturalization and political experience, treatment of immigrant heritages, neighborhood agencies and organizations and rural developments. Show which of these have important relationship to health education?

7. Some newspapers conduct a question and answer column on personal health. Do you know of a paper that conducts a similar column for public health and sanitation?

8. Plan the details of a community Health Week, including its advertisements, exhibits, speakers, and publications for distribution.

9. Recently some of the largest "chain" restaurants have been printing the calorie value of each order of food. Should "package foods" be similarly graded?

10. Have you seen in your postoffice the recent Public Health Service poster about malaria mosquitoes? Is that a legitimate expenditure of public money?

11. Collect all the health superstitions in your community, such as "a few drops of lemon juice makes any water safe to drink." Show why each is harmful, and present convincing arguments to confute it.

See Reference List at end of Appendix.

CHAPTER XXVI

HEALTH ADMINISTRATION

ALTHOUGH the ultimate control of local sanitary conditions rests with the several States, the federal government has charge of various important public health relations. How wide a range these cover is shown by Fig. 115.

History of the Federal Service.—The lower right-hand corner of that chart gives the various names by which the present Public Health Service is known. It really dates back to 1798 when Congress passed an act for the relief of sick and disabled seamen. This small beginning accounts for the present location of the bureau in the Treasury Department, the customs service having always been closely connected with the medical care of seamen.

The National Board of Health established in 1879 for four years only was purely advisory and one of its chief duties was to "report to Congress . . . a plan for a national public health organization." Since the bill authorizing it did not carry any appropriation, it dropped out of service and the national health functions reverted to the earlier Marine Hospital Service mentioned on the chart.

Powers of the Public Health Service.—Quarantine is so directly one of the marine problems that control of quarantine naturally became part of the work of this growing department. By various laws enacted by Congress the powers of this department have come to include not only port quarantine of incoming people, but (1) exclusion powers regarding aliens; (2) quarantine control of incoming goods and merchandise; (3) interstate control of communicable diseases;[1] (4) the interstate regulation of serums, vaccines, etc.; (5) the sanitary equipment of interstate carriers (trains, boats); (6) the control of malaria, meningitis and other commu-

[1] The Public Health Service exercises interstate quarantine over plague, cholera, typhoid fever, pulmonary tuberculosis, yellow fever, smallpox, leprosy, typhus fever, scarlet fever, diphtheria, measles, whooping cough, infantile paralysis, meningitis, and Rocky Mountain spotted or tick fever.

nicable diseases in areas adjoining military and naval reservatio The Public Health Service provides medical care of the employ of various branches of the government, continuing, of course, original charge of the marine service, maintaining (year endi June, 1917) 19 marine hospitals and 119 relief stations.

Advisory Relations.—The advisory character of this fede department is also very important. The Surgeon General, as ch of the Public Health Service, is required to hold each year at le one conference with the State health authorities; this provides o portunity for the discussion of current sanitary problems, and he toward uniformity in public health legislation and administratio The Public Health Service also frames model laws and codes fo the various States, establishes standard registration forms (Fig 108 and 109), conducts local investigations of epidemics (*e.g.*, smallpox) or sanitary problems, including such varied questions a pellagra, rural sanitation, mental hygiene, industrial wastes, rat control in plague-infested localities, and the pollution of streams. The annual report of Surgeon General Blue for the year ending June, 1917, is a most interesting and enlightening document of nearly four hundred pages, and many more details can be gained from even a casual reading of this report.

Certain other powers relating to public health are vested in the Department of Agriculture; these have been mentioned under adulteration of foods and meat inspection, which also covers quarantine for foot-and-mouth disease. At present still further federal control of public health is contemplated; this includes supervision of the State health departments and the establishment of minimum requirements and standards below which no State will be allowed to fall.

State Health Departments.—The State departments vary greatly, as one might expect in a country like the United States, where State constitutions and legal standards vary so greatly. That but twenty-six States are included as wholes in the "registration area" (G) tells the tale. How far the States often fall below the city standards is shown by the fact that the registration area includes thirteen cities in States not included in the twenty-six above.

Winslow estimates that an efficient State department can be run for five to ten cents per capita. The State department should be the department for final appeal concerning food (including

milk), water, sewage, and epidemics. Private influence often prevents the *local* health board from condemning a milk supply, enforcing the repair of leaky sewers, and enforcing the registration and quarantine of communicable diseases. A case in point is the smallpox epidemic that raged unchecked in Niagara Falls until the State department intervened. Diagnostic work (tests for typhoid, identification of carriers, and examination of dogs for rabies) is legitimate State work, for it is to the interest of the State to control such diseases in all communities too small or too poor to do this work for themselves. In large States enough substations for such diagnostic work should be established to enable reports on samples or specimens to be obtained within twenty-four hours. If established in connection with hospitals, colleges, and medical schools, a sufficient number might easily be secured at a minimum cost and with profit to the institutions themselves.

State departments should also, by health education or publicity work, uphold the local departments, and increase their efficiency by increasing a local sense of pride and responsibility. They should also establish minimum standards below which no community can fall—whether it be with regard to the infant mortality rate, the percentage of industrial diseases, the imperfect birth registrations, or adulterated drugs and foods.[2] These are best indicated by a sanitary code or set of regulations which should be distributed widely, so that local communities can realize when they can seek protection or support through the State health department. For example, communities have suffered for years the annoying and dangerous results of broken sewers or sewers that empty into adjoining waters above low-tide levels, not knowing that the State could and would protect them.

State departments should include in their codes all the regulations enforced by the federal government regarding interstate communication. Meat killed in New York State, but not fit to be shipped across the State line to Massachusetts or New Jersey, should not be sold in New York State, either. It is a sad commentary on our State laws to be told that many people, perhaps in your own

[2] Some States have separate Pure Food Commissions not part of the health department. This paragraph is not an argument for changing such organization (though centralization is usually desirable), but rather for the establishment and enforcement of good standards.

State, insist on western meat, thus securing through the United States interstate regulations safe meat which they cannot trust their own State to provide them. Alcoholic candies, adulterated drugs, and injurious foods may be sold in quantities in your State by manufacturers who find it more profitable to cater thus dishonestly to a small market than to supply clean and correctly labelled commodities for interstate trade.

Local Health Departments.—The local health department is, of course, our main interest. Often a local health department can exercise wider powers than the State, particularly if local public sentiment is with it. The State department can be more effective in an impartial enforcement of existing regulations, but the local departments are much more elastic, and can modify their powers almost at will. Its functions and organization should be somewhat along the line indicated by the accompanying diagram, modelled after that recommended by Winslow. This includes an advisory body or "board of health" working with an executive termed a health officer. In large communities his work must be distributed among several health departments, as indicated in the diagram (Fig. 116).

The board of health is primarily concerned in an adequate sanitary code. This should be as brief as possible and leave out all regulations not applicable to the community (*e.g.*, industrial restrictions in communities not containing any factories, foundries, etc.).

The executive power should be vested in one person, a health officer, who is also chairman or president of the health board. The board may consist of representative and interested business men, or preferably, in small or rural communities, of the school inspector or nurse, a physician of good standing, the county or other local registrar or official interested in permanent and correct records, and the health officer. In all cases executive action should be vested in one man who can give sufficient time to the work. It often occurs that the health officers (or board members) are employed in neighboring cities and are not easily reached by the people they would serve, being absent all day, and loth to have their home or personal plans upset by irregular outside calls. The usual monthly meetings do not offer adequate opportunity for the needs of the people, especially in the problems of communicable diseases. Every com-

munity should itself, or in conjunction with the neighboring townships, support a department of health in which a health officer can be recompensed for the time given to the community. Often members serve without any compensation and cannot, therefore, always put the public first.

If the State will provide adequate diagnosis facilities at convenient centres, even rural communities could afford a part-time health officer for the other needs of the community. Samples and specimens sent for diagnosis could be paid for directly on a cost basis, or indirectly in the State taxes. Local health organizations cost, according to the Russell Sage Foundation, anywhere from

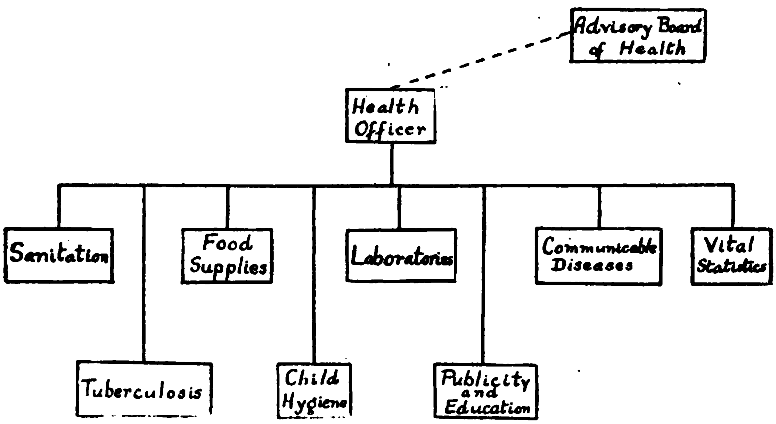


FIG. 116.—Diagram of the various subdivisions recommended for local health departments. (After Winslow: Healthy Living.)

three-fourths of a cent per capita (Clinton, Iowa) to ninety-eight cents (Seattle). New York City spends fifty-eight cents per capita and has probably the most efficient health department in the United States. The average cost is thirty-two cents, but the rate varies inversely with the population. For a small town or country district with a population of 4000 the average rate, thirty-two cents, would give us but $1280, which could not possibly secure a well-trained health officer and also a school nurse or medical inspector. The Massachusetts scheme of co-operation among a few experts who make contracts with a number of small towns is worth considering, though

enough should be raised by the community for a reliable health officer responsible to the community. Often, the wide area covered daily by the country physician makes him a desirable person for this work. His training prepares him more definitely for the different phases of this work than does the training of most people in the community. A small salary would enable him to add this duty, for that would enable him to secure a clerk or other helper for mechanical phases of his own work or parts of the health office work (*e.g.,* filling out records, mailing samples for diagnosis, follow-up work regarding quarantine, compulsory repairs to sewers, etc.). In small localities the health board or department is often lethargic or actually incompetent. Often the positions are accepted for political or selfish reasons. Public health education is the only agency that can permanently affect the personnel of our local health departments, and insure its people adequate and disinterested service (see Chapter XXV).

PROBLEMS

1. Send for the Interstate Quarantine Regulations issued by Public Health Service in 1916. Support the rulings given there for ice, water, rat-proof warehouses, restrictions on the transportation of patients, and the shipment of animals.
2. Describe the organization of the health work in your State.

GLOSSARY

Note.—These definitions are not meant to be complete technical definitions, but to aid a beginner in reading this text. (See Preface for further explanation.)

Acne. A skin disease commonly affecting the sebaceous glands of the face, the several types characterized by dilated blood-vessels, types of eruption, etc.

Aërate. To expose to the action of air; to force air through.

Agar. The term agar is used both for a substance expressed from seaweed and for a combination of that substance and meat broth which makes a solid medium for cultivating bacteria. It forms a semi-transparent substance resembling gelatin in appearance (see pp. 10 and 11).

Agar Plate. A glass dish (Fig. 8) containing a layer of agar in or which bacteria may be grown (see Figs. 67 and 75).

Agglutinins. Substances accumulating in the blood as a reaction to bacterial growth or action; these substances cause the bacteria to clump together or agglutinate (Fig 61) as a preparatory step to their destruction by the on white corpuscles.

Algæ. Plants of relatively simple structure, commonly growing in water. Common illustrations are the slimy green scum on ponds and the stringy green masses on dock piles, etc. Bacteria are usually classed in the lowest division of the algæ, though bacteria do not possess the green coloring matter characteristic of most algæ.

Alkali. A compound of hydrogen and oxygen with such substances as sodium or ammonium; these compounds are very soluble in water and can neutralize acids. Lime and any other compound that has neutralizing power for acids are popularly spoken of as alkalies.

Alveolar. The ultimate fine subdivisions of the lungs are tiny rounded sacs or pouches called *alveoli*. The air held in these sacs is spoken of as *alveolar* air.

Anaphylaxis. See p. 210.

Antibodies. Reacting substances formed by the body and accumulating in the blood in response to bacterial growth or action. These include antitoxins, agglutinins, opsonins, and lysins as discussed in this text.

Antiseptic. Against or preventing sepsis (or decay). In treating wounds, it is not always sufficient to make sure that the dressings are aseptic (G). The wound itself may have in it injurious bacteria which came from the air, the near-by surface of the body, or which got in at the time of injury. Sterile or aseptic dressings will

not prevent injurious organisms from developing. To hinder their development, chemicals are sometimes used either on the dressings or applied directly to the wounds. Since these prevent sepsis, they are called antiseptics. Care must be taken that antiseptics are not too strong, or they will destroy the body cells, or at least irritate them and so delay healing.

Antitoxins. The substances or antibodies formed in the body in response to the irritating or poisonous toxins of such bacteria as diphtheria and lockjaw are called antitoxins. These antitoxins neutralize the toxins, but do not aid the white corpuscles nor themselves destroy the bacteria. We are most familiar with the word antitoxin in connection with the formation of such substances in large quantities by the horse, which enables us to use the blood of such horses to protect human beings (pp. 198 and 199).

Arthritis. A disease of the joints with symptoms resembling rheumatism or gout.

Aseptic. Aseptic means without decay or sepsis (see septic). Wounds should be kept in an aseptic condition and substances in contact with wounds should be aseptic, that is, without any decaying particles or any organisms that could cause sepsis. All sterile substances are aseptic. Dressings and instruments may be made aseptic by boiling, by subjecting them to hot steam, or by such chemicals as alcohol and chloroform. If other chemicals which do not evaporate, such as carbolic acid or corrosive sublimate, are used for dressings, they are usually made antiseptic rather than merely aseptic (see antiseptic).

Auto-intoxication. The digestion or breaking down of protein foods includes many temporary or transitional stages, some of which are poisonous. Nervous or other functional derangements of the digestive processes may lead to the accumulation and absorption of unusual amounts of intermediate poisonous stages; this self-poisoning is termed auto-intoxication (see food poisoning also).

Autopsy. An examination of a dead body to determine the cause of death, the seat of the disease, etc.; a post-mortem examination.

Bacillus (plu. **Bacilli**). A rod-shaped bacterium; usually used for the forms possessing motility or the power to form spores (Figs. 2 and 102).

Bactericidal. Able to kill bacteria; carbolic acid, alcohol, etc., are bactericidal substances.

Bacterin. (See vaccine.) Bacterin is sometimes used as a name for killed cultures of bacteria which are used to produce immunity to a given disease. The vaccine used in typhoid prevention is technically a bacterin.

Blood Count. A count of the total number and proportion of white and red corpuscles. This count is made by putting a carefully measured amount of accurately diluted blood on a special slide, which

holds a given amount of blood over an area marked off in tiny squares to facilitate counting. The count is made through a microscope (Fig 1).

Botulism. Food poisoning due to the formation of toxin by *B. botulinus*, usually in meats which have been incompletely cooked or preserved, or which have stood too long since cooked. (See p. 44.)

Calorie. A unit for measuring heat, used commonly to express the fuel value of foods. A calorie as used in that connection is the amount of heat necessary to raise 1000 grams of water 1° Centigrade.

Calorimeter. (1) Bomb calorimeter: an apparatus, with a carefully constructed or insulated chamber to prevent outside conditions from influencing the results, in which foods for fuels can be tested to determine the heat or energy they represent. (2) Respiration calorimeter: a similar chamber, large enough to hold an animal or a person, used to determine the heat or energy used under varying conditions.

Carbohydrates. A general term for sugars and starches (see each in Glossary).

Carbon Monoxide. Carbon monoxide (CO) is a very injurious gas which, being odorless, often accumulates in fatal amounts before the danger is realized (see p. 132).

Carrier. (See p. 176.)

Centigrade. The Centigrade thermometer has but one hundred divisions or grades (therefore, literally centigrade) between freezing and boiling. The thermometer in the Appendix gives the corresponding Centigrade and Fahrenheit temperatures with rules for translating one scale into the other.

Centrifuge. The principal part of a centrifuge is a horizontal disk or wheel which can be revolved very rapidly—by hand power or machinery. In this disk are little cavities in which tubes or flasks of liquids (*e.g.*, whole blood, bacterial cultures) may be suspended. As the speed of the disk increases, these tubes tend to take a position approaching the horizontal, and the heavier substances in these liquids, *e.g.*, bacteria, blood corpuscles, or dust particles, thrown outward by centrifugal force, settle in the ends of the tubes. The top or lighter part of the tube contents can then be poured off, and the heavier part (bacteria, corpuscles) obtained relatively free from the other substances. Liquids of different density may be similarly separated from each other by centrifuging.

C.C. (See cubic centimeter).

Certified Milk. (See p. 86.)

Clinical. This term refers to immediate or direct examination of a case; it commonly includes the symptoms which might be determined by observation at a bedside or in a hospital.

CO. (See carbon monoxide.)

CO_2. Carbon dioxide.

Coccus (plu. Cocci). (See p. 3.)

Colonies. (See p. 11.)

Communicable. Diseases readily transferred from one person to another are now spoken of as communicable. This term is supplant-

ing the older term contagious (see p. 172).

Contagious. (See p. 172.)

Cubic Centimeter (c.c.). A small unit of size used in the metric system, now so commonly used in scientific measurements and descriptions. A cubic centimeter of water weighs 1 gram; it can be visualized better by remembering that a cubic centimeter of such liquids as water contains about 16 drops. The word mil is sometimes used for one cubic centimeter, as it is one thousandth of a litre, the larger liquid unit (a little over 1 quart).

Diagnosis. A careful study of existing conditions and a conclusion based upon the characteristic signs or symptoms thus observed. A diagnosis is commonly based upon clinical (G) symptoms only; at present an examination of bacteriological or pathological material is often made to confirm the clinical diagnosis, *e.g.*, typhoid.

Dialysis. The passing of soluble substances through membranes: plant or animal cell membranes, or artificial membranes, such as dialyzing bags (see osmosis).

Diastase. An enzyme which changes starch to sugar or sugar to starch.

Dietary. A diet system, *e.g.*, a hospital dietary.

Disinfect. To render free from infectious or disease-producing organisms; this does not mean that no micro-organisms are left, but that there are none which can cause disease. Usually, however, there are few or none in disinfected materials or substances. (See sterilize, which is a stronger term.)

Distilled. Water is distilled by first boiling it and then collecting and cooling the steam or vapor, thus condensing it back to water. This distilled water does not contain the minerals and organic materials present in the original water. If collected and cooled in sterile vessels, it may be *sterile* water as well, though distilled water is not necessarily sterile water, as spores are sometimes carried over in the steam, especially from rapidly boiling water.

Effluent. That which flows forth or out, *e.g.*, the water flowing out from the bottom of a filter.

Endemic. Applied to any disease produced and propagated by local conditions; *e.g.*, malaria and hookworm are endemic in certain areas of the United States.

Enzymes. Substances produced by living cells which bring about definite changes in those cells, their food materials, or their stored substances, *e.g.*, diastase.

Ether. A supposed medium which fills all space and through which all energy, including light, is thought to be transferred by wave-like motion.

Eustachian Tube. A tube connecting the cavity between the nose and throat with the ear. Infection from the mouth, etc., very easily spreads into this tube and so into the ear, often penetrating the spongy (mastoid) bone near the ear (mastoid abscess).

Fats. Such foods as lard, butter, salt pork, peanut butter, bacon, cream, oleomargarine, olive oil, are classed as fats.

Fæces. The discharges from the intestines or bowels.

Fluorides. Salts, such as sodium fluoride.

Fomites. Substances capable of absorbing, holding, and transporting infectious micro-organisms; mucus, clothing, etc., come under this heading.

Food Poisoning. This is a general term applied to all stomach or intestinal disturbances due to foods. It covers conditions caused by foods naturally poisonous (*e.g.*, certain mushrooms), by introduced chemicals (*e.g.*, preservatives), by toxins found in the food before it is eaten (as in botulism), or more rarely still, by ptomaines; the most common cause of food poisoning is due to the activity of organisms after they are swallowed with the food. (See p. 44.)

Food Sensitives. (See p. 210.)

Germicidal. Used for substances or agents that can kill germs or micro-organisms. Acids, high temperatures, etc., have germicidal power. Germicidal substances are also called disinfectants.

Glycogen. A starchy substance commonly called "animal starch," which is formed in the liver. As needed, it is changed back to sugar and distributed by the blood.

Gonorrhœa. A dangerous disease affecting such delicate membranes as the eyes and the genital area. It is sometimes transferred through soiled towels, bedding and personal articles, as well as by personal contact.

Gram. A unit of weight. One cubic centimetre of pure water at its greatest density (4° C., or 39° F.) weighs one gram. Gram and cubic centimetre are, therefore, practically interchangeable for water, but not for very light, heavy or dry substances.

Ground Water. The water which is found in the depths of all soils, and which has an irregular indefinite upper boundary known as the water table. Capillary water is the term applied to the water above the ground water or water table.

Hæmoglobin. The compound responsible for the coloring matter of red corpuscles and important as a carrier of oxygen. Color tests to determine the per cent. of hæmoglobin are often important in diagnosis.

Hookworm. Small round worms (*Necator*) which cause hookworm disease (see p. 176).

Host. An organism that harbors another as a parasite. In typhoid or hookworm man acts as host for the typhoid or hookworm organisms.

Hydrolyzed. Hydrolysis is a chemical change attended by or dependent upon the presence of water. Many enzyme changes are of this kind; for example, when starch is changed to sugar the addition of water is the first step.

Immunity. This is defined as freedom or exemption from; the

literal meaning, "not in service to," carries the same implication.

Incubation. When bacteria are kept at temperatures favorable for growth or multiplication, they are said to be incubated. We also speak of the time period when bacteria are multiplying in the body as the incubation period; this extends from the time when the disease organism enters the body to the time the patient "comes down" with the disease.

Inert. Neutral; devoid of active chemical properties.

Infection. Disease organisms that multiply in the body cause infection. Infection may be localized, as in a boil, or general, as in blood poisoning.

Infectious. Caused by disease-producing organisms, or capable of producing disease through the transfer of such organisms.

Inhibited. Prevented from growing or multiplying in number. Chemicals which sterilize or disinfect in strong solutions may only inhibit bacterial growth or action when used in weaker solutions.

Inoculate. To introduce directly into the body, as into the skin, the abdominal cavity, or a blood-vessel; used mainly for the introduction of micro-organisms; curative substances (serum, etc.) are more commonly spoken of as *injected.*

Inorganic. Not now or never having been a living organism; mineral rather than organic is an easily understood difference, though organic substances contain minerals (see organic).

Lactic. Commonly applied to milk changes, such as lactic fermentation. The lactic acid produced in souring milk is common in many other substances containing sugar.

Latrine. A privy, especially the trough type common in camps or barracks.

Lactose. Milk sugar.

Larvæ. The stage following the egg stage in such insects as the fly, butterfly, etc. It is usually a maggot or a worm-like stage.

Leaching. Separating or washing out soluble matter by draining or percolating.

Lesions. Injuries, diseased areas, or morbid changes in organs or tissues; these include bruises, ulcers, and inflamed as well as disintegrated areas.

Lymph-nodes. Small lymph-glands or collections of lymph tissue. Certain types of white corpuscles are produced in these lymph-glands.

Lysins. Substances (antibodies) formed in the body as a reaction to bacteria or other micro-organisms (see p. 194).

Media. Substances used for the cultivation or growth of micro-organisms; milk, beef broth, gelatin are common media. Special media are used for certain organisms; these may contain egg (tuberculosis), serum (diphtheria), special sugars, etc.

Medulla Oblongata. The extension of the spinal cord just within the

skull; it is an important centre for breathing, swallowing, etc.

Metabolic. See metabolism.

Metabolism. A comprehensive term for all the cell changes, including the change of stable non-living food substances to complex unstable living material and the breaking down of that living material to simpler and more stable substances; metabolism includes all the upbuilding and energy-producing changes in a cell.

Metric System. A system of weights and measures commonly used in Europe, and now generally adopted in this country for scientific work. It is much simpler than our own systems, and has small units more suitable for fine measurements. The only units used in this text are the cubic centimetre and the gram, which are described in this glossary. The Centigrade thermometer is based on the same system of units, varying by tens or hundreds.

Micro-organism. An organism of very small size, making a microscope necessary for its detailed study.

Mil. (See cubic centimetre.)

Motility. The power of locomotion.

Mucus. The viscid secretion of certain membranes; we are most familiar with it as the excessive secretion of such membranes as the nose and throat attending colds.

Nephritis. An inflammatory disease of the kidneys affecting the secretory tubules.

Non-pathogenic. Not capable of causing or producing disease.

Opsonins. Antibodies produced as a reaction to invading organisms which aid the white corpuscles in digesting and destroying them (see p. 196).

Optimum. Used to designate the condition or conditions producing the best results.

Organic. All organic substances contain carbon as an essential element; usually applied to substances which are or have been part of living organisms; flour, milk, and spores are organic substances in contrast to iron rust, table salt and air, which are inorganic (see inorganic).

Osmosis. The term osmosis is now often limited to the passage of water through membranes, dialysis being used for the passage of substances in solution such as sugars, salts, and acids. There is a constant exchange of substances in and out of cells by these two processes.

Oxidation. The union or combination of oxygen with other substances. Oxidation breaks down or decomposes many complex substances; this change in structure from the complex to simpler forms liberates energy. Much of our energy (and heat) is obtained by oxidizing food substances, hence the need for a rich blood supply of oxygen. Foods are sometimes split into simpler substances without oxygen entering into the change; oxidation is usually, however, the more economical way of producing cell energy.

Parasite. An organism which lives upon another living organism. Tapeworms, bacteria and molds which cause ringworm are examples of human parasites.

Paratyphoid. An intestinal disease, or the organism producing it; it resembles typhoid, therefore, the prefix, *para* (see p. 44).

Paresis. A partial or a general, progressive paralysis; advanced stages cause one type of "softening of the brain."

Pasteurization. As applied to milk, pasteurization means heating the milk to a temperature which insures the killing of all pathogenic organisms which might occur in milk. For the changes attending such heating of milk see Fig. 28 and p. 82.

Pathogenic. Capable of causing or producing disease.

Pathogens. Used to designate micro-organisms which are capable of causing or producing disease.

Pellagra. A deficiency or nutritional disease with various clinical manifestations: intestinal disturbances, skin eruptions or "burns," and nervous derangements, such as melancholia and mania.

Peristaltic. A term referring to the rhythmical movement of the small intestine.

Petri Dish. A double glass dish or plate used to cultivate micro-organisms (Fig. 8). (See also agar plate.)

Phagocyte. (See white corpuscles.)

Phthisis. Tuberculosis, especially the pulmonary (or lung) type.

Plasmolysis. A shrinkage or collapse of the cell attendant upon the loss of water. The "keeping power" of brines and strong sugar solutions is due to their power to abstract water from micro-organisms, and so prevent them from growing.

Plate Counts. Plate counts are made to determine the number of bacteria in a given amount of milk, water, etc. (See plate count in Appendix.)

Poliomyelitis. Infantile paralysis.

Polluted. Containing organic material, the products of plant or animal decay (see p. 93).

Potable. Fit or safe to drink.

Precipitate. To cause to fall or settle more rapidly than would otherwise occur.

Precipitins. Substances found in the blood as a reaction to foreign bodies in the blood stream, such as bacteria and the blood-cells of another animal (see p. 194).

Presumptive Tests. Because of the difficulty in identifying bacteria by their shape and size, we depend partly on their products or results when grown in certain food materials. For example, *Bacillus coli* can use lactose, forming acid and gas with a definite proportion of hydrogen and carbon dioxide. If water or milk containing this same organism is added to lactose broth, we get much the same results. Knowing this, we use lactose as a test substance, and use it for testing water, milk, etc. If the results are like those obtained from

B. coli growths, we conclude or presume that *B. coli* is present. Such tests are called presumptive tests (see p. 98).

Protein. The most important or foundation substance of all cells or organisms, as indicated by the literal meaning of the word, *first in*. White of egg is a good common example of proteins. Proteins—more or less mixed with other foods such as starches—are derived from such foods as beans, peas, skim-milk, American cheese, lean meats, and eggs.

Protozoa. The lowest group of animals, simple one-celled forms (see Figs. 46, 4 and 3).

Ptomaines. These are alkaloid-like substances, formed in the decomposition of proteins (amino-acids). Some of them are poisonous, though most are not (see food poisoning).

Pulmonary. Relating to the lungs, as pulmonary tuberculosis.

Putrefaction. Decay or decomposition, especially the types accompanied by the formation of objectionable odors; these are very commonly due to organisms which do not get their energy by oxidation.

Registration Area. That part of the United States in which the death record part of the vital statistics is thought to be at least 90 per cent. correct. It now includes 26 States and certain cities in 13 other States.

Respiration. Respiration is essentially a cell process, another name for the oxidation processes of the living body. Breathing is an accessory to respiration, but is not respiration itself—as now generally used in this chemical sense.

Rickets. A nutritional disease of children, characterized by malformation of the skeleton and lack of muscular control or co-ordination.

Saprophyte. An organism which lives on organic material, but not on a living host. Bacteria or molds living on bread, dead fish, milk, are all saprophytes. Most bacteria are saprophytes.

Saturated (Saturation). When a liquid has dissolved or absorbed all it can of a given substance, it is said to be saturated, or to make a saturated solution. Air may be similarly spoken of as saturated with water.

Scurvy. Authorities differ as to the relative causal importance of diet and micro-organisms in this disease, which is characterized by anæmia, debility, bleeding gums, and scab-like manifestations on the skin.

Sepsis. See septic.

Septic. Undergoing or showing signs of decay. A septic tank is one where sewage is held until it decays or decomposes past the ordinary malodorous stages. A septic wound has decay-producing organisms growing in it; pus, "proud flesh" are indications of such septic conditions.

Serum. The liquid of the blood (plasma) lacking not only the red and white corpuscles but the fibrin of the plasma as well. (See whole blood.)

Siphon. To discharge over or through a bend in a pipe or tube. The S-curve in a trap makes a siphon (Fig. 68). The water pressing down toward the trap has sufficient force to carry the water up over the curve or bend, making a continuous stream of water or siphon. Though less evident at first, the siphon action can be seen in water closets (Fig. 73) as well as in simple S-traps.

Sludge. The semi-solid part of sewage left after crude sewage has been filtered, or acted upon by bacterial action. (See septic tank and activated sludge tank also.)

Spirillum (Spirilla). One of the classes of spiral-shaped bacteria is called *Spirillum; Vibrio* is another class of very short spirals. (See *Spirochæta.*)

Spirochæta. The protozoa include a group of spiral-shaped organisms called *Spirochæta.* Spirochætes cause such diseases as relapsing fever and syphilis.

Spore. A stage in the life history or development of some bacteria. Spores are quite resistant to most unfavorable conditions, and are usually formed in response to such environmental influences.

Sputum. Mucus accumulating in or ejected from the mouth or throat.

Stains. Special dyes or stains are used to color bacteria so they may be seen more definitely. No real progress was made in identifying bacteria until after the discovery of anilin dyes by Perkin.

Starches. Foods like hominy, cornmeal, flour, rice, macaroni, spaghetti, cornstarch, bread, beans, peas, potatoes, and bananas are rich in starch and spoken of as starchy foods. Peas, beans, whole wheat flour are also rich in proteins as well.

Sterile. Free from micro-organisms.

Sterilize. To free from all microorganisms by such agents as heat or chemicals. A stronger term than disinfect, which has as its aim killing all disease-producing organisms.

Streptococci. Coccus or globular organisms, which adhere in chains. A rather long-chained type is shown in Fig. 58.

Sugars. Fruits such as dates and raisins are rich in sugar; more condensed sugars are cane sugar, beet sugar, candy, molasses, corn syrup and honey.

Syphilis. A dangerous disease sometimes transferred by common drinking glasses, towels, bedding, or personal articles, as well as by personal contact.

Tetanus. Lockjaw organisms or the disease caused by them.

Therapeutic. Having curative or healing properties.

Trephining. Removing a small disk or piece of the skull to remove presure upon the underlying part of the brain, remove injured tissue, etc.

Trichinella (Trichina). Round worms (as opposed to flat worms like tapeworms) which live in pigs as well as man. They injure mainly by perforating the intestinal walls and invading the muscles.

Toxins. Poisons formed by bacteria. These toxins may be excreted freely and accumulate in the blood, irritating the body cells generally, as in diphtheria, or they may affect definite tissues, as the nerve tissue in lockjaw (tetanus).

Trypanosomes. Protozoa causing diseases in animals, but none common in man in this country (Fig. 3).

Tuberculin. (See p. 216.)

Vaccine. Vaccine is a term used for substances, such as bacteria, which are inoculated into the body to protect it against disease. Vaccines are made of either living or dead organisms; *e.g.*, living in smallpox vaccine and dead ones in typhoid vaccine. If living organisms are used, they are first weakened in some way to lessen their effect (see pp. 203–205).

Virulent. Highly pathogenic or extremely toxic or poisonous.

Virus. A term for unknown causal agents of disease. The material used to vaccinate against smallpox is commonly spoken of as smallpox virus. Similarly we speak of the virus of hog-cholera, and of foot-and-mouth disease. When the causal organism is known, it is usually spoken of by its group name (Streptococcus, Trypanosome, Spirillum, etc.) or by the general names bacteria or protozoa.

Vital Resistance. The resistance of living organisms against such untoward agents as bacteria and fatigue. Upon the individual resistance depends the individual's freedom from disease, or the severity of the attack. This resistance is in great part dependent upon the activity of the white corpuscles, and the production of such antibodies as antitoxins and opsonins.

Vitamines. (See p. 27.)

Water Gas. Illuminating gas made by passing steam through a mixture of hydrocarbons (carbon and hydrogen compounds).

White Corpuscles. The blood contains two kinds of corpuscles, red and white. The white corpuscles vary more than the red in size and activity; although several kinds are found in all human blood, they may be divided into two main groups, those that contain but one nucleus and those that contain several nuclei. White corpuscles, though relatively few in number, are most important; they help in blood clotting, in keeping a protein balance in the blood, etc. Those possessing several nuclei have another important function: they surround or envelop and finally digest bacteria, thus protecting the body against invading organisms. Sometimes dozens of bacteria may be seen inside one white corpuscle (Fig. 50; see p. 195.)

Whole Blood. Literally whole blood, without subtracting the corpuscles. Blood less corpuscles is spoken of as plasma; if the fibrin is also taken out, it is called serum; in clotted blood the liquid serum collects at the sides or top of the jar or container.

APPENDIX

DISINFECTION

In this appendix are treated only the disinfectants not included in the table on p. 189 and those for which special directions are necessary. The present high price of carbolic acid and related substances is the reason for omitting them. In this connection, reference may be made again to the commercial high-coëfficient disinfectants (p. 191), calling attention to their value and warning patrons to purchase only those with a definite statement concerning the carbolic acid strength or coëfficient.

Bichloride of mercury is not included, partly because it is now impossible to buy it without a physician's prescription in most intelligent communities, and partly because carelessness is attended with so many serious results, making its use inadvisable when so many satisfactory substances are available.

Formaldehyde Disinfection.—Formaldehyde or formalin is usually purchased in 40 per cent. solution. Formaldehyde is not a good insecticide; this fact leads some to question its value as a disinfectant, but formaldehyde is one of the best gas disinfectants known for rooms, etc., as it injures but few substances. Its advantages and disadvantages may be summed up as follows: A powerful germicide, little affinity for other organic matter, not poisonous, and not injurious to delicate fabrics, paints, metals (except iron on prolonged contact). Disadvantages: Not reliable when the temperature is much below 65° F., irritating to the eyes and nose, and requires a long period of exposure and considerable preparatory work (*e.g.*, sealing cracks).

Liquid Disinfectant.—For a liquid house disinfectant, dilute the formaldehyde as purchased (40 per cent.) by adding ten times as much water. This mixture will disinfect small articles immersed in it in ten minutes. Excreta covered generously with this mixture (at least as much mixture as excreta) will be disinfected in two to three hours. Bedding, etc., can be satisfactorily soaked in the same mixture; this may be desirable if the attendants cannot be certain that soiled articles will be boiled before handling. Formaldehyde is irritating to the hands and therefore not popular as a liquid disinfectant.

Room Disinfection.—For closets, chests, etc., the formaldehyde as purchased (40 per cent.) can be used, distributing 10 ounces for each 1000 cubic feet to be disinfected. All cracks, keyholes, etc., should be sealed by pasting on strips of paper before disinfection is begun. After spraying, close the compartment, closet, etc., for at least eight hours.

For rooms, formaldehyde can be used as above. It is better, however,

to modify the method to make sure of two factors that increase the efficiency of the formaldehyde: (1) Moisture, which increases the penetrating power of the formaldehyde; and (2) heat, which increases its chemical action. This is usually done by using potassium permanganate with the formalin, but as it is often impossible to get potassium permanganate in many localities, the following directions are given: Secure an old watertight cooking utensil which you can afford to discard. In it place the necessary amount of formaldehyde, 10 ounces as purchased to every 1000 cubic feet, adding about the same amount of water. When ready to leave the room, place it over a flame or fire (gas burner, oil stove or lamp, etc.) and leave the room *promptly* because of the effect on the eye and nasal membranes. If convenient, leave the room closed until the next day; on re-entering, open the door wide for a short time and then open the nearest window quickly, retiring until the irritating effects are not noticeable.

Lime.—For disinfection do not use air-slaked lime, but "quicklime." It can now be purchased in tin cans in small quantities. Add one pint of water to two pounds of quicklime. If rapid effervescence and crumbling or dissolving of the lime does not occur, the lime is not of good quality and will not disinfect as rapidly or as completely in the proportions advised. To this slaked lime, add four times as much water, mixing thoroughly. Keep it in airtight containers as a stock solution for use as needed. This stock solution will disinfect excreta in two hours; it may be used in outhouses, chicken yards, etc.

Bleaching Powder or Chlorinated Lime.—Bleaching powder (see p. 108) may now be purchased in small tin containers (5 cents and upward). It should bear a label stating plainly the amount of available chlorin. Commercial forms usually contain at least 30 per cent. (though the United States standard demands 35 per cent.). For use, rub the contents of the can up in a little water, making a pasty mass, and then dilute to the desired strength; six ounces of bleaching powder to a gallon of water is the general stock solution for 30 per cent. bleaching powder. It bleaches textiles and corrodes metals and its odors are readily absorbed by food, so its house uses are somewhat limited. This substance has an affinity for organic matter, and should, therefore, be used generously in disinfecting excreta, which contains much organic material besides the bacteria we desire to destroy. Add at least equal parts of stock solution to discharge.

Bleaching powder is sometimes valuable in emergency treatment of water. One teaspoonful of bleaching powder (35 per cent. available chlorine) is added to a pint of water to make a stock solution. The clear fluid of the stock is sufficiently strong, as chlorine is very soluble. This stock solution may be used as follows: one teaspoonful to 10 gallons, 36 drops to a gallon, or nine drops to a quart. Let the solution stand at least 15 minutes, preferably 25 minutes (drinking water, washing lettuce, p. 235).

The administration of bleaching powder as purchased in bulk is not a simple matter, and needs to be carefully controlled to insure a known strength. For swimming pools bleaching powder seems the best disinfectant. Those responsible for the care of such pools should secure the advice of the State department of health concerning reliable firms for purchasing good hypochlorites and details of mixing and administering.

HOUSEHOLD PESTS

Flies.—House control can be secured by traps (see p. 279), by sticky fly-paper (especially the strips, which do not demand table or other needed horizontal surface for exposure), and by fly-poisons. Of these poisons, formalin is perhaps the most satisfactory, as it is not so poisonous to man as other recommended substances. Add four ounces of formalin to a quart of milk, or a quart of sugar and water, and moisten crusts of bread placed in light places.

Electric fans at doorways will keep flies from entering, as they dislike strong winds. Strong odors, such as decomposing food, will attract flies. Odors pleasant to man are said to be disagreeable to flies; and good results are attributed to lavender water, etc., when sprinkled around the room. Water is necessary for life; perfectly dry sinks, crumbless tables, etc., have a slight negative effect, therefore.

Stable refuse is the favorite breeding place of most flies, and proper care of manure will help greatly—closed pits, etc. Such pits are not always possible, and chemical treatment is necessary. Borax (one pound to 12 gallons of water) will treat 12 bushels or 16 cubic feet of manure, destroying 90 per cent. of all maggots. If not more than 15 tons of such treated manure is added per acre, the crops do not seem to be injured. Hellebore is also effective in the proportion of one-half pound to 10 gallons of water used for every eight bushels or ten and two-thirds cubic feet.

Other Household Pests.—Ants, cockroaches, and bedbugs may have hygienic problems connected with their activities. Ants may be eliminated by spreading near their haunts equal parts of powdered sugar and tartar emetic. This causes such violent purging that death ensues.

Cockroaches, croton bugs, can usually be controlled by generous distribution of sodium fluoride, mixed with equal parts of flour, talc, etc. Sodium fluoride is the basis of most roach powders.

Bedbugs are not so readily affected by formaldehyde as by sulphur. Painting beds, woodwork, cracks, etc., and repapering are usually very helpful measures. Kerosene is a good substance for painting cracks, bedsteads, springs, etc. Corrosive sublimate (saturate solution) is most efficient, but because of its very poisonous character it cannot be purchased in many localities. It discolors plaster, but can safely be applied with a brush on most other surfaces.

Rats and mice should be exterminated. Rat-proof walls, floors, and foundations should be used everywhere, and when necessary these should be supplemented by some of the various good traps now on the market.

PASTEURIZATION OF MILK

Pasteurization of Milk.—Some milk stations and city baby-welfare stations sell at cost price a pasteurizer for home use. They may also be purchased in many department stores, at about $1.25 to $1.75 each. For other homes the following directions may be helpful, as they do not demand a thermometer. Thermometers are expensive and easily broken. (1) Fill each of six milk bottles to the level demanded by the age or the size of the child. (2) Tie on each bottle a cap of clean paper to prevent a milk film from forming: this also keeps flies away from the milk while cooling, etc. (3) Place the bottles in a wire basket or frame (vegetable frame) in a large cooking utensil (six-quart size or thereabouts). The frame holds the bottles erect, and prevents cracking of the enamel of the vessel. (4) Add water until it is slightly above the level of the milk in the bottles. (5) Heat over the fire until the bubbles begin to rise and break on the surface. (6) Remove the vessel from the stove, covering the whole top with a clean cloth, and allow it to stand so covered for 25 to 30 minutes. (7) Lift out the wire frame with the bottles and stand it to cool in a shallow pan of running water, or place immediately in the ice-box. (8) Keep the milk in the ice-box until it is used.

PLATE COUNTS

Plate Counts.—Plate counts of the bacteria in a given bulk of milk, water, etc., are made by taking a given amount of such substances (*e.g.*, 1 c.c., G) and mixing it with a tube of melted but cooled agar and then pouring this mixture into a sterile Petri dish (Fig. 8). The mixture hardens, forming a layer in the bottom of the plate, and is then left at a favorable temperature to allow the organisms in it to develop into colonies or visible masses. After two (or three) days the colonies are counted, and the number of colonies taken as an indication of the condition of the milk, water, etc., which was used. (It is not thought, of course, that all of the bacteria present will find the temperature, food, etc., favorable to growth.) When the substances contain large numbers of bacteria, one cubic centimetre would contain more than could develop on a single plate. It is the common practice to use dilutions of the original substances in such cases, adding a given unit, such as 1 c.c., to a large amount of sterile water (10 c.c., 100 c.c.) and making plates of a small amount (*e.g.*, 1 c.c.) of this dilution. In testing milk, eggs, etc., very weak dilutions are usually necessary, *e.g.*, a thousandth or a ten-thousandth dilution. When dilutions are used the number actually developing on the plates is multiplied by the dilution to give the probable number of bacteria per c.c.

GARBAGE DISPOSAL

Present Army Methods of Disposal.—A recent letter from the Conservation and Reclamation Division of the Army states that "all garbage is sold by the government to the highest bidder. Garbage is collected in the greater number of camps by the government and turned over to contractor at transfer stations. The prices on contracts vary greatly, but all bids are made on four distinct classes of kitchen garbage as follows: (*a*) bread; (*b*) raw and cooked meats, and fats and grease; (*c*) bones; (*d*) other garbage.

"In some instances, contractors render all of the garbage, getting all possible grease and fats therefrom, while in other instances garbage is put through what is known as a fat-boiling process, which renders about 50 per cent. of the fats. The garbage is then fed to hogs. In some camps, this division purchased small rendering plants and at the present time has under consideration the operation of a large number."

Horse manure also may be disposed of by contract for fertilizer. This year's income for that is said to be over $250,000.

Improved incinerators are being developed. One of the best seems to be the Williamson multiple shelf incinerator. It is very simply constructed and needs but 200 pounds of wood to start it. It is a "simple rectangular chimney four and one-half by six feet inside diameter. It has a grate, and above this grate comes a series of six iron plates, arranged in zigzag fashion as baffle plates." It is worked through two small doors opposite each shelf. The shelves are loaded to a depth of three inches, and the contents are pushed down from shelf to shelf, and finally to the grate. If "enough garbage is supplied it will burn indefinitely." At Camp Funston, over nine tons of garbage have been taken care of in twelve hours. This type of incinerator seems well adapted to small communities as well as army uses. (See also p. 335.)

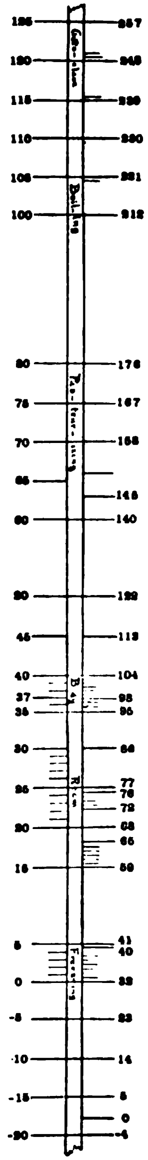
TRAINING FOR PUBLIC HEALTH OFFICIALS AND WORKERS

Among the universities which have already established correlated courses in public health work are Harvard, Johns Hopkins, and Yale. These universities offer not only courses covering two or more full years, but also single, short courses for the special groups of health officials, *e.g.*, industrial inspectors.

Additional training for nurses fitting them for public health work may be secured at George Peabody College, Nashville, Tenn.; School of Civics and Philanthropy, Chicago; School for Social Workers, Richmond, Va.; Simmons College, Boston; Teachers College, Columbia University; and Western Reserve College, Cleveland, Ohio.

During the past two years several other private and State institutions have offered one or more part-time training courses in such work. Those occupied or interested can secure from their State health departments additional information regarding such opportunities for preparatory work.

TEMPERATURE SCALES



To convert degrees Fahrenheit into degrees Centigrade:

- subtract 32,
- multiply by 5,
- divide by 9

To convert degrees Centigrade into degrees Fahrenheit:

- multiply by 9,
- divide by 5,
- add 32

GENERAL REFERENCES

The following books will be useful as references for practically all the chapters of this book. The date of the last edition is given; many of these books have frequent new editions and that should be determined before a purchasing list is decided upon. Extensive lists are given in some of the General Reference books listed below, especially Rosenau. No attempt is made to include the numerous helpful government publications, such as the publications of the Bureau of Animal Industry on milk and cheese. For such material write to the Superintendent of Documents, Washington, D. C., for such lists as Price List 51 on Health, Disease and Sanitation. Various States and cities have important publications, such as the Sanitary Code of New York City and of New York State, and the weekly bulletins of New York City and the monthly bulletins of New York State and New Jersey.

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Sedgwick: Principles of Sanitary Science. Macmillan, N. Y., 1914.

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Chapin: Sources and Modes of Infection. Wiley, N. Y., 1912.

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More advanced references are given under the general references above.

II. **The Human Mechanism in Relation to Health:**

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Hough: The Human Mechanism. Ginn, Boston, 1906.

Stiles: Human Physiology. Saunders, Philadelphia, 1916.

III. **Food:**

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Service and Regulatory Announcements. Bureau of Chemistry, Washington (Concerning adulteration, etc.).

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IV. **Milk:**

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MacNutt: The Modern Milk Problem. Macmillan, N. Y., 1917.

Milk and Its Relation to Public Health. Bull. 56, Public Health Service, 1909.

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Parsons: Disposal of Municipal Refuse. Wiley, N. Y., 1906.

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Howard: The House Fly. F. A. Stokes, N. Y., 1911.

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Ross: The Reduction of Domestic Flies. Lippincott, Philadelphia, 1913.

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Dorset: Some Common Disinfectants. Farmer's Bulletin 926, 1918.

Quarantine Regulations and other publications by the Public Health Service.

to modify the method to make sure of two factors that increase the efficiency of the formaldehyde: (1) Moisture, which increases the penetrating power of the formaldehyde; and (2) heat, which increases its chemical action. This is usually done by using potassium permanganate with the formalin, but as it is often impossible to get potassium permanganate in many localities, the following directions are given: Secure an old watertight cooking utensil which you can afford to discard. In it place the necessary amount of formaldehyde, 10 ounces as purchased to every 1000 cubic feet, adding about the same amount of water. When ready to leave the room, place it over a flame or fire (gas burner, oil stove or lamp, etc.) and leave the room *promptly* because of the effect on the eye and nasal membranes. If convenient, leave the room closed until the next day; on re-entering, open the door wide for a short time and then open the nearest window quickly, retiring until the irritating effects are not noticeable.

Lime.—For disinfection do not use air-slaked lime, but "quicklime." It can now be purchased in tin cans in small quantities. Add one pint of water to two pounds of quicklime. If rapid effervescence and crumbling or dissolving of the lime does not occur, the lime is not of good quality and will not disinfect as rapidly or as completely in the proportions advised. To this slaked lime, add four times as much water, mixing thoroughly. Keep it in airtight containers as a stock solution for use as needed. This stock solution will disinfect excreta in two hours; it may be used in outhouses, chicken yards, etc.

Bleaching Powder or Chlorinated Lime.—Bleaching powder (see p. 108) may now be purchased in small tin containers (5 cents and upward). It should bear a label stating plainly the amount of available chlorin. Commercial forms usually contain at least 30 per cent. (though the United States standard demands 35 per cent.). For use, rub the contents of the can up in a little water, making a pasty mass, and then dilute to the desired strength; six ounces of bleaching powder to a gallon of water is the general stock solution for 30 per cent. bleaching powder. It bleaches textiles and corrodes metals and its odors are readily absorbed by food, so its house uses are somewhat limited. This substance has an affinity for organic matter, and should, therefore, be used generously in disinfecting excreta, which contains much organic material besides the bacteria we desire to destroy. Add at least equal parts of stock solution to discharge.

Bleaching powder is sometimes valuable in emergency treatment of water. One teaspoonful of bleaching powder (35 per cent. available chlorine) is added to a pint of water to make a stock solution. The clear fluid of the stock is sufficiently strong, as chlorine is very soluble. This stock solution may be used as follows: one teaspoonful to 10 gallons, 36 drops to a gallon, or nine drops to a quart. Let the solution stand at least 15 minutes, preferably 25 minutes (drinking water, washing lettuce, p. 235).

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Castle: Heredity in Relation to Evolution, etc. N. Y., 1911.
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